Resilience scan | April-June 2016

A review of literature, debates and social media activity on resilience

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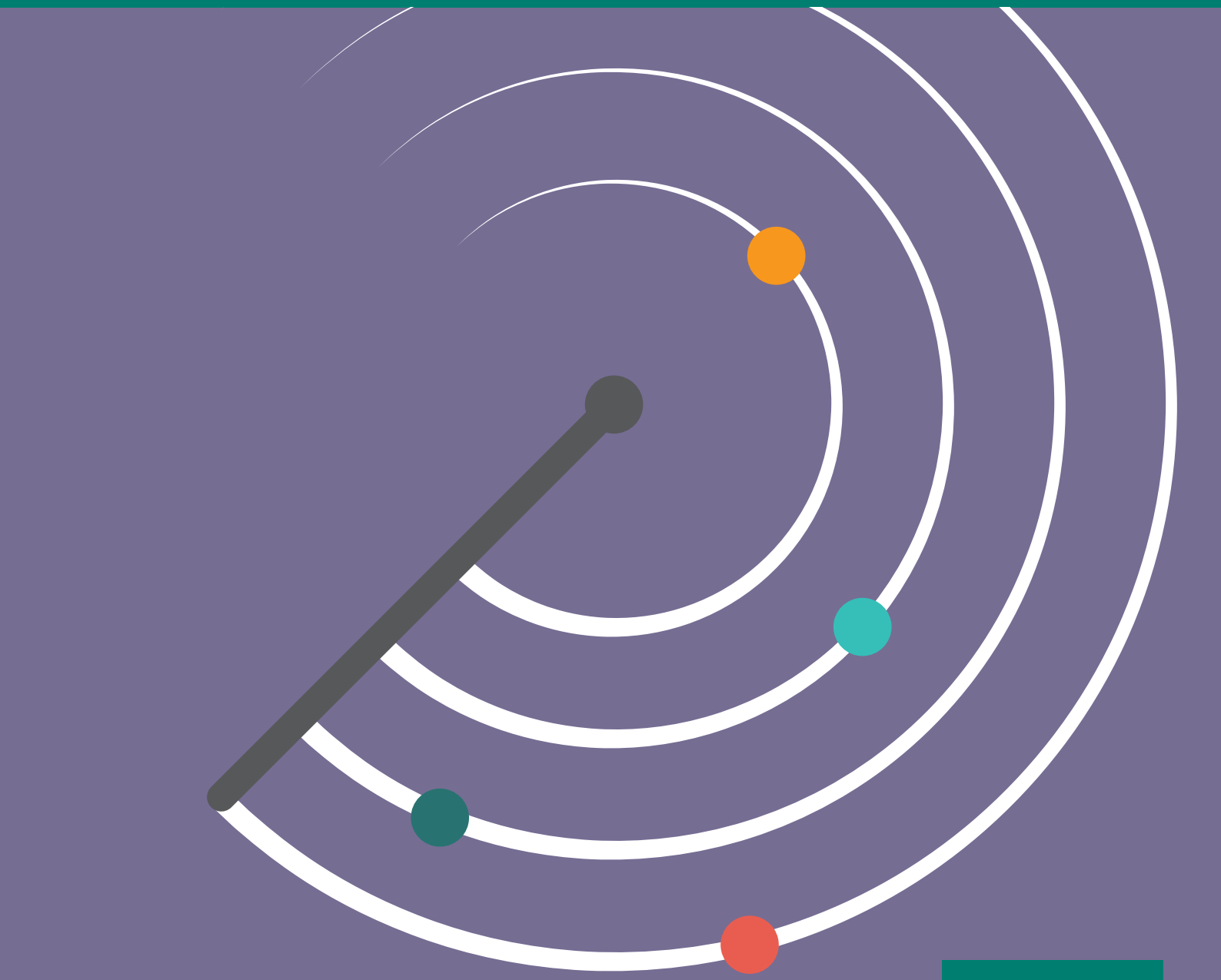

REPORT

This report was written by Thomas Tanner, Emma Lovell, Florence Pichon and Pandora Batra. We gratefully acknowledge the inputs of Lara Langston and Hani Morsi in assisting with the search and methodology. Section 1 would not have been possible without inputs of experts Dr Paul Watkiss, Dr Courtney Cabot Venton, Dr Jules Siedenberg and Dr Matthew Savage.

Our thanks also to Chukwudi Onike and Kevin O'Neill (Rockefeller Foundation) for their helpful feedback and support. Design was by Steven Dickie and communications support from Ashleigh Kate Slingsby.

The quarterly resilience scans are complemented by 'deep-dive' analytical papers that focus on emergent aspects of resilience thinking and practice. To date we have published deep-dives focusing on measurement of resilience, assessing 'subjective' resilience, psychological resilience, bottom-up innovation, and a 'Big Picture' analysis of the first 5 Resilience Scans. Coming soon: Resilience in the Post 2015 Frameworks; Resilience and Urban Migration; and Key Challenges for the Resilience Agenda.

Please see **www.odi.org/resilience-scan** for details of these papers and previous resilience scans.

Suggested citation:
Tanner, T., Lovell, E., Pichon, F. and Batra, P. (2016) 'Resilience Scan April–June 2016: A review of literature, debates and social media activity on resilience'. London: ODI.

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The ROCKEFELLER FOUNDATION

This report received support from The Rockefeller Foundation.

Abstract

This ‘resilience scan’ summarises writing and debates in the field of resilience during the third quarter of 2016, focusing primarily on the context of developing countries. The scan will be of particular interest to those implementing resilience projects and policies and those seeking summaries of current debates in resilience thinking. It comprises: insights on improving the business case for investing in resilience; summaries of key blogs, grey literature and academic journal articles on resilience; and the insights from this literature for five characteristics of resilience - awareness, diversity, self-regulation, integration and adaptiveness.

Contents

List of figures and tables

Figures

Tables

Acronyms

100RC	100 Resilient Cities
ADB	Asian Development Bank
ADRRN	Asian Disaster Reduction and Response Network
AIDMI	All India Disaster Mitigation Institute
APA	Ad Hoc Working Group on the Paris Agreement
ASALs	Arid and Semi-Arid Lands
ASEAN	Association of South-East Asian Nations
BRACED	Building Resilience and Adaptation to Climate Extremes and Disasters
CBA	Cost–Benefit Analysis
CCA	Climate Change Adaptation
CCD	Climate-Compatible Development
CRM	Climate Risk Management
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
FAO	Food and Agriculture Organization
FCAS	Fragile and Conflict-Affected States
FEMA	Federal Emergency Management Agency
FEWS	Flood Early Warning System
FSC	Food Supply Chain
GFDRR	Global Facility for Disaster Risk Reduction
GIS	Geographical Information System
IMS	Interim Monitoring Survey
JRP	Joint Resilience
M&E	Monitoring and Evaluation
MUB	Multi-Nutrient Urea Block
NGO	Non-Governmental Organisation
NRM	Natural Resource Management
PPP	Public–Private Partnership
PRIME	Pastoralist Areas Resilience Improvement and Market Expansion
RIMA	Resilience Index Measurement and Analysis
RISE	Resilience in the Sahel-Enhanced
SDG	Sustainable Development Goal
UN	United Nations
UNDP	UN Development Programme
UNESCO	UN Educational, Scientific and Cultural Organization
UNICEF	UN Children's Fund
US	United States
WFP	World Food Programme
WSD	Watershed Development

Executive summary

Business cases for investing in resilience

The rising burden of disaster losses suggests that compelling business cases are needed for investments to build resilience and protect human and environmental systems from damage. This opening section highlights challenges and emerging strategies for creating resilience business cases. These include:

- Defining resilience: Creating a common collective vision among stakeholders for building resilience at the outset can help to shape a common definition of resilience-building parameters and objectives.
- Improving data: Tackling data challenges to quantify the benefits of resilience, particularly for harder to calculate benefits of investing in 'soft' systems such as institutional capacity, mainstreaming, or management systems.
- Incentivising longer term decisions: Building on existing development challenges, using scenarios, asking the right questions and demonstrating an understanding of future uncertainties, rather than trying to provide all the right answers.
- Emphasising 'Resilience Dividends': Incorporating resilience dividends in calculating benefits and business cases for investment. Such dividends are delivered irrespective of whether a disruption occurs.

Top blogs on resilience

Twenty-five of the most influential blog posts on resilience (published between January and June 2016) were identified and reviewed under thematic clusters linked to climate, urban development, finance, conflict and gender.

Resilience in grey literature

Our analysis of publications on resilience published by research and private sector institutions, donors and multilateral agencies between April and June 2016 includes 36 papers spanning six broad themes:

Grey literature on *agriculture, livelihoods and food security* suggests:

- There is a need for increased public and private agricultural investment that specifically targets smallholder farmers and women.
- There is a need for improved natural resource management and biodiversity protection, which is vital to building resilient agricultural value chains.
- Livelihood diversification does not necessarily result in increased resilience, particularly in areas with a lack of high-return, non-climate-related livelihood activities.
- There is a need for an integrated cross-sectoral approach to augmenting weather and climate information systems.
- Successful and resilient food supply chains feature flexible actors and diversified sources of crops. Enhanced resilience requires the integration of the value chain approach and climate risk management practices within broader policies and systems.

Grey literature on *urban resilience* suggests:

- Women are particularly vulnerable to climate risks in urban areas, owing to increased engagement in climate-sensitive livelihoods and lack of information and opportunities for participation in decision-making processes.
- Effective promotion of urban disaster risk reduction (DRR) combines financial and non-financial incentives that are specifically tailored to the capacities and requirements of the area.
- Access to affordable climate-resilient housing can be enhanced through the provision of context-specific and appropriate mortgages and microfinance mechanisms.

Table 1: Top blogs on resilience

Rank	Title	Link
1	Resettling the first American 'climate refugees'	http://www.nytimes.com/2016/05/03/us/resettling-the-first-american-climate-refugees.html?_r=0
2	How to achieve flood resilience? Embrace innovation	https://www.devex.com/news/how-to-achieve-flood-resilience-embrace-innovation-88003
3	#WaterWindow: Amplifying the conversation on flood resilience	https://www.devex.com/news/waterwindow-amplifying-the-conversation-on-flood-resilience-87987
4	A coalition for greater impact: 1 billion people on the path to resilience	https://www.devex.com/news/a-coalition-for-greater-impact-1-billion-people-on-the-path-to-resilience-87674
5	Researchers find the tipping point between resilience and collapse in complex systems	http://www.northeastern.edu/news/2016/02/researchers-find-the-tipping-point-between-resilience-and-collapse-in-complex-systems/
6	From homogenous to indigenous: Investing in native food systems for a resilient future	https://www.christensenfund.org/2016/03/30/from-homogenous-to-indigenous-investing-in-native-food-systems-for-a-resilient-future/
7	More than just a flood defence: How Vejle built a blueprint for resilience	https://www.theguardian.com/cities/2016/may/19/flood-defence-vejle-denmark-resilience
8	The rise of resilience planning	http://www.100resilientcities.org/blog/entry/the-rise-of-resilience-planning#/-_/
9	Making climate resilience a core part of city development	http://www.100resilientcities.org/blog/entry/making-climate-resilience-a-core-part-of-city-development#/-_/
10	Boulder's essential green: Moving beyond concrete as a strategy for resilience	http://www.100resilientcities.org/blog/entry/boulders-essential-green-moving-beyond-concrete-as-a-strategy-for-resilienc#/-_/
11	Coastal cities look to resilience chiefs to combat climate change	http://www.scientificamerican.com/article/coastal-cities-look-to-resilience-chiefs-to-combat-climate-change/
12	Unlocking urban resilience through innovative partnerships	https://www.rockefellerfoundation.org/blog/unlocking-urban-resilience-through-innovative-partnerships/
13	Climate change gardening – building resilience from the ground up	https://www.theguardian.com/lifeandstyle/gardening-blog/2016/feb/25/climate-change-gardening-building-resilience-from-the-ground-up
14	From disaster victims to frugal innovators: Learning from communities how to build resiliency	http://blog.brac.net/2016/03/from-disaster-victims-to-frugal-innovators-learning-from-communities-how-to-build-resiliency/
15	Climate resilience must be a global priority	https://www.rockefellerfoundation.org/blog/climate-resilience-must-be-a-global-priority/
16	Rising tides: Debt-for-nature swaps let impact investors finance climate resilience	https://global.nature.org/content/rising-tides-debt-for-nature-swaps-finance-climate-resilience
17	Living with water in the Netherlands and at sea	http://thegroundtruthproject.org/living-with-water-in-the-netherlands-climate-change/
18	Empowering women empowers communities	https://medium.com/@UNICEF_Sudan/unicef-fao-wfp-joint-resilience-project-jrp-empowering-women-empowers-communities-7410b4bebff#.rxneeofep
19	Pathways to resilience: evidence on links between conflict management, natural resources, and food security	https://www.newsecuritybeat.org/2016/04/pathways-resilience-evidence-links-conflict-management-natural-resources-food-security/
20	If we want a resilient world, we need to start with resilient data	http://datadrivenjournalism.net/news_and_analysis/if_we_want_a_resilient_world_we_need_to_start_with_resilient_data
21	Building climate resilience in cities: Lessons from New York	http://theconversation.com/building-climate-resilience-in-cities-lessons-from-new-york-52363
22	Investing in resilient infrastructure before disaster hits	http://www.brookings.edu/blogs/the-avenue/posts/2016/06/06-disaster-deductible-vajjhala
23	Rebuilding societies: Strategies for resilience and recovery in times of conflict	http://www.atlanticcouncil.org/publications/reports/rebuilding-societies-the-strategies-for-resilience-and-recovery-in-times-of-conflict
24	Fragility, conflict, and natural disasters – a 'one-size fits all' approach to resilience?	http://blogs.worldbank.org/voices/fragility-conflict-and-natural-disasters-one-size-fits-all-approach-resilience
25	The growing role of women in disaster risk management	http://blogs.worldbank.org/endpovertyinsouthasia/women-coastal-india-take-disaster-risk-management-their-own-hands

Grey literature on *measuring resilience* suggests:

- There is a need for a clearly defined and tested 'menu' of indicators of resilience that cover a range of different sectors/topics and types of outcomes and impact.
- The use of the term 'resilience' has increased exponentially over the past 10 years across policy, social media and academia.
- When measuring resilience, capacities beyond demographic and economic factors must be considered (i.e. human capital, social networks and subjective measures of shock impact).
- There is a need for increased time series data in order to observe and determine the effects of long-term vs. short-term coping strategies and their consequences on resilience.

Grey literature on *social aspects of resilience* suggests:

- There is need to include psychosocial factors and subjective measures in theories of change and measurement, alongside more tangible variables, in order to build an understanding of what factors contribute to resilience at different levels.
- Social capital has a significant positive relationship with variables that indicate resilience.
- Greater equality is a major driver of higher resilience.
- There is a need for increased investigation into the appropriate location for subjectivity within resilience measurement research.
- Underlying inequalities can be tackled through gender-sensitive strategies that recognise the interests, capacities and power relations between women and men.

Grey literature on *finance and social protection* suggests:

- There is a need for new and improved approaches and increased funding for DRR interventions in fragile and conflict-affected states.
- 'Responsive social safety nets' are conventional social safety nets with built-in mechanisms that allow existing programmes to be scaled up after a disaster.
- Social protection initiatives are most able to contribute to climate resilience when they are flexible, scalable, long term and highly climate-responsive.

Grey literature on *frameworks and organisational approaches to resilience* suggests:

- Frameworks for building resilience must be gender-sensitive, systems-focused and process-oriented.
- Frameworks must be coordinated, integrated and flexible in order to support a multitude of contexts.
- Development and implementation of construction/building regulations are required to address underlying risk in built environments.
- Flood early warning systems must be end-to-end and include risk knowledge, risk monitoring, communication and dissemination, and support people's ability to respond to a flood event.

Resilience in the academic literature

We included 25 peer-reviewed papers in the analysis of academic papers on resilience published between April and June 2016, from which four dominant thematic clusters emerged:

Academic literature on *multi-scalar and cross-sectoral adaptation* suggests:

- A legal framework with clear allocation of responsibilities for climate adaptation and resilience actions is essential to collaborate effectively across scales of governance.
- Private sector involvement in climate change adaptation is limited. Without a better understanding of the drivers of adoption of climate adaptation actions by corporations and a method of evaluating outcomes, efforts to adapt to climate change will neglect the role of the multinational and large corporations.
- Focusing on the institutional conditions that foster resilience-building is as important as resilience outcomes, particularly in understanding what prevents local, national and regional governments from undertaking adaptation actions.
- Understanding local institutional histories is key to adding nuance to resilience measurement and scoring that relies on quantitative global and regional-level indicators.
- Climate adaptation planning should consider the vulnerability of critical infrastructure and the possible cascading impacts onto socioeconomic systems.

Academic literature on *power, perceptions and subjective resilience* suggests:

- Efforts to enhance resilience must consider issues of power and conflict to understand whose resilience is privileged and potential trade-offs in resilience-building.
- Perceiving climate impacts is important for adopting climate adaptation actions, and interventions that enhance understanding of climate impacts to facilitate resilience and decision-making at the household level.
- Subjective resilience can complement objective resilience measurement, capturing intangible factors that shape resilience and reveal underlying patterns of vulnerability.
- Perceptions of the role of interventions in enhancing livelihood resilience may differ from the impacts detected by models, with households overestimating the impacts of interventions.

Academic literature on *adaptive capacity in agro-ecological systems* suggests:

- A vast array of factors affect the resilience of socio-ecological and agro-ecological systems. Tracking the resilience of these systems requires a monitoring components of resilience that span social, ecological, cultural and economic indicators.
- There are low rates of adoption of climate adaptation actions by smallholder farmers, and many of the barriers to adoption manifest at scales higher than the household, including issues of market access, land tenure systems and infrastructure.
- Supporting adaptive capacity must consider the short-term costs and benefits of adoption of climate-smart agriculture techniques, promoting techniques that yield positive impacts in the one- to two-year timescales that smallholder farmers prioritise.
- Mapping social and ecological factors geospatially is key to informing local decision-making and planning for resilience.

Academic literature on *migration and displacement* suggests:

- Debates on migration as an adaptive response to climate change have neglected issues of interconnectedness between places of destination and home, and the role this plays in resilience of individuals and communities.
- Current research on social-ecological resilience can shed light on the interactions between migrants and ecosystems.
- Ensuring resilient livelihoods in cases of forcible relocation should build on the organic livelihood processes that emerge after relocation.

1. Improving the business case for resilience

The rising burden of disaster losses suggests that more compelling business cases are needed for investments to build resilience and protect human and environmental systems from damage. Such evidence and innovative approaches can help to counter the disincentives to action stemming from uncertainty about future disturbances. This opening section of the resilience scan discusses this critical part of the incentive structure for investing in resilience, highlighting challenges and opportunities. It draws on inputs from experts working on resilience business cases.[1] While many of the examples cited relate to the fields of disaster risk reduction (DRR) and climate change adaptation (CCA), similar issues and challenges are encountered in relation to other fields of resilience, including ecosystem management, economic resilience and prevention of humanitarian emergencies.

1.1 Defining resilience in business cases

In developing practical business cases, an initial but fundamental challenge lies in defining what resilience means. This task needs to include defining the system of interest (resilience of what?), the shocks and stresses of most interest (resilience to what?), whose or what's resilience is being enhanced (resilience for whom?) and to what end (protect life, protect assets, protect functions, etc.). Different groups of people involved in the investment decision may have very different perspectives and interests with respect to these questions. For example, in restoring a peri-urban wetland habitat, some people may be interested in protecting biodiversity whereas others may seek flood protection for high-value housing, industrial areas or informal settlements.

One way of brokering differences among stakeholders is to create a common collective vision for building resilience as a critical step in developing business cases. Approaches such as that employed by Rebuild by Design in the US seek to overcome these challenges by bringing together local communities, civic leaders and other stakeholders in a collective creative process to generate implementable resilience solutions.

'One way of brokering differences among stakeholders is to create a common collective vision for building resilience as a critical step in developing business cases'

Initial definitions also need to define the financial sustainability criteria for any resilience-building measures. Some may be designed as initial trials for later market adoption, others as publicly provided goods and others with public–private partnerships (PPPs) in mind. For example, Solidarités International has trialled 'multi-nutrient urea blocks' (MUBs) in northern Kenya as a food supplement to enhance the resilience of livestock so they can survive climatic shocks such as drought and erratic rainfall, while also increasing their milk production. While MUBs provide a promising solution to pasture scarcity, challenges remain around their affordability for pastoralists and the viability of credit-based approaches.

1.2 Overcoming data challenges to quantify the benefits of resilience

Cost–benefit analysis (CBA) has historically been used to measure costs against expected benefits. It has classically been used for more straightforward single investments (such as whether to build a new bridge), where data can either be readily estimated from existing documentation or easily measured from observable phenomena. The benefits of resilience-building measures are often more complex, dependent on interactions with many other variables, and are less well studied. As such, demonstrating the benefits of an intervention in ways that are compelling to decision-makers can be difficult, even when such an intervention is clearly

1 Many thanks to Dr Paul Watkiss, Dr Courtney Cabot Venton, Dr Jules Siedenberg and Dr Matthew Savage for providing invaluable inputs to this section based on their considerable collective experience in developing business cases for resilience-building initiatives.

highly beneficial to target communities. Economic costs and benefits are highly location- and sector-specific, and the choice is either to rely on proxies for economic returns that may not be entirely comparable or to undertake significant ex-ante appraisal, which can be very expensive.

Some types of investment in resilience lend themselves more easily than others to strong business cases. This can lead to bias in decision-making, with the choice reflecting the available data rather than the best course of action. Most often, it is easier to calculate the additional costs and potentially avoided losses of 'hard' investments such as protective infrastructure based on engineering designs. However, many of the investments required for resilience are in institutional capacity, policy and planning, mainstreaming, information and monitoring. The benefits of such actions are much harder to see, as the resulting changes to resilience are more complex or are less likely to happen in the same way in all systems.

One way to examine soft measures is to look at the economic value (e.g. a sector budget) and understand what level of improvement in effectiveness of spending would be required to justify the investment, or how much such investments might leverage from other funds for additional investment. Yet, in the real world of resource constraints and time pressures, there is still likely to be a bias towards actions where data on costs and benefits are more easily and more quickly compiled. In addition, many resilience benefits are associated with non-market goods and services – which makes valuation challenging.

There are also difficulties in calculating what the future losses would be without the resilience-building measure. Developing such 'counterfactuals' is highly uncertain given the wide range of possible future hazards (especially under climate change) and the changing exposure of human systems under different economic development pathways. This work also needs to factor in how much resilience would be created without a specific investment, either through autonomous measures or through other initiatives or government programmes. In order to tackle such uncertainties, sensitivity analysis is increasingly seen as a fundamental requirement in any appraisal of options for strengthening resilience.

1.3 Incentivising benefits delivered over a longer timescale

Investments in resilience against longer-term impacts rather than commonly recurring shocks and stresses also suffer from the use of high discount rates in CBA calculations that reduce the value of future benefits in today's terms. At the same time, investments in resilience typically cost more upfront – so it is necessary to get people to view it as an investment over the longer term, and this doesn't always fit with government terms or with the public wanting to see results for their money. One option is to use lower discount rates for intergenerational benefits, but this also creates the need for alternative economic appraisal approaches that incorporate robustness or flexibility (particularly in relation to long-life infrastructure) or look at the value of information.

Uncertainty around the nature, extent and severity of hazards also frustrates business cases. It is not always clear when a disaster or disruption will happen. This is even more pronounced in the case of CCA, where the economic appraisal is expected to incorporate the change in future hazard burdens. Decision-makers are increasingly asking 'If the climate is changing then what needs to be done differently?', but the uncertainty of the projected change and the heavy discounting of benefits that occur far into the future complicate the answer.

This challenge has been tackled in a variety of ways. Many investments combine longer-term benefits with delivery on shorter-terms priorities. The Coffee and Climate (www.coffeeandclimate.org) collaboration between the coffee sector and international development partners tackles the challenges climate change is posing to the coffee value chain. Central to its success has been building resilience aspects into solutions to existing challenges identified by farmers, such as small volume production and low purchase prices from middlemen. By combining improved production techniques with pyramid-structured producer groups, farmers are able to sell their coffee at a price some 40% higher than before, despite climate change, while also building their skills.

Future uncertainty can also be tackled through the use of a range of future scenarios, which allows decision-makers to assess options for enhancing resilience in terms of their flexibility to incorporate future changes and whether they are robust to deliver resilience across different possible futures. Iterative risk management frameworks can also help identify low-regret options by supporting the framing, sequencing and prioritisation of early CCA measures – from national and programmatic level through to individual projects (see www.vfmadaptation.com; Watkiss et al., 2014). Investing in resilience therefore requires a shift in business cases towards seeking to ask the right questions and demonstrating an understanding of the uncertainties, rather than trying to provide all the right answers. Business cases describe the choices within an economic and theory of change framework in the most transparent way possible.

1.4 Incorporating resilience dividends in business cases

Finally, an emerging approach to strengthen business cases for investing in resilience moves away from a singular focus on losses as a driver for action towards the recognition and appraisal of a broader set of 'resilience dividends' (Rodin, 2014; Tanner et al., 2015). This business case builds on understanding of the ancillary benefits or co-benefits of action and asks how investments to build resilience can be good for wealth, well-being, profit, growth and sustainable development, even in the absence of a disruptive event.

Existing methods of appraising investments to build resilience undervalue the associated benefits. This is linked to the common perception that investing in resilience will yield benefits only once disaster strikes. This leads decision-makers to view investments as a gamble that pays off only in the event of a disaster. However, there is increasing evidence that building resilience yields significant and tangible benefits, even if a disaster does not happen for many years.

'...there is increasing evidence that building resilience yields significant and tangible benefits, even if a disaster does not happen for many years.'

Judith Rodin's 2014 book, *The resilience dividend*, provides multiple examples of how investments enable individuals, communities and organisations not only to better withstand a disruption more effectively but also to build new relationships, take on new endeavours and initiatives and reach out for new opportunities. Tanner et al. (2015) examine the resilience dividend in two elements in addition to avoiding losses when disruptions occur: first is the unlocking of more entrepreneurial and innovative investment decisions in the absence of background risk, and second is the delivery of development co-benefits from multi-purpose investments, such as river embankments that act as pedestrian walkways, parks or roads; strengthened disaster early warning systems that strengthen weather forecasting capacity; and disaster shelters that can be used as schools or community spaces.

Understanding these dividends and incorporating them into planning and decision-making is critical to strengthening the business case for investments. Presenting evidence of additional dividends to policy-makers and investors can provide a narrative reconciling short- and long-term objectives, thereby improving the acceptability and feasibility of investments to strengthen resilience.

For further reading on improving the business case for resilience, please see the section in the reference list.

2. Top blogs on resilience

2.1 Methods

This section offers insight into how the blogosphere writes about and discusses the concept of resilience, by identifying and analysing the blog posts on resilience published in the final quarter of 2015. Annex 1 describes the methodology, which is based on a social visibility score. We identify 25 of the most influential blog posts on resilience published between January and June 2016 and analyse them within thematic clusters. This provides an alternative lens through which to understand the key debates and topics dominating the resilience discourse.

2.2 Climate resilience

Five different blog posts focus on climate resilience, with flooding and migration appearing as dominant climate resilience-related themes. The highest ranked blog post in terms of visibility, 'Resettling the first American "climate refugees"', discusses a new climate resilience grant put in place by the US Department of Housing and Urban Development worth $1 billion. This grant includes the first allocation of resources ($48 million) to relocate an entire community of 60 residents whose lives and quality of life are threatened by the impacts of climate change. The blog post describes the logistical and political complications of utilising planned relocation as an adaptation strategy, and notes three previous failed resettlement attempts dating back to 2002. It also highlights the limitations and challenges in scaling up this sort of initiative. The remainder of the grant is aimed at helping communities adapt to flooding as a result of climate change by building stronger levees, dams and drainage systems in areas at risk. These hard engineering solutions are also reflected in the Dutch fjords, as described in the blog post 'Living with water in the Netherlands and at sea' (ranked 17th), which looks at communities and households that have evolved their cultural identity around managing sea level rise and flooding. The article therefore suggests that, in regions of the world where sea level rise owing to climate change is threatening to overwhelm cities and livelihoods, important lessons can be learnt from the people of Holland, who have been dealing with and slowly adapting to similar issues for generations.

While these hard engineering solutions have proved effective in many contexts, two blog posts highlight the need for innovative ideas to increase flood resilience that go beyond traditional management methods. 'How to achieve flood resilience? Embrace innovation' (ranked 2nd) and '#WaterWindow: Amplifying the conversation on flood resilience' (ranked 3rd) both

Indigenous knowledge for resilience in marginal drylands, Tunisia. Photo: CGIAR Research Program on Dryland Systems, 2013.

discuss the new Water Window project developed by the Global Resilience Partnership and Zurich Insurance Group, which offers up to $1 million in grants for innovative ideas that build climate resilience. Both blog posts highlight the dominant focus of funding on response and recovery and the deficit in relation to reducing and managing risks. The Water Window project is described as unique in its multi-sectoral approach, encouraging innovative solutions in the areas of technology, financing, risk transfer mechanisms, measurement, policy and learning and innovation. The project is also presented as an incubator for small-scale projects as well as a means of encouraging smaller organisations that perhaps demonstrate more creativity and flexibility than larger ones. Continuing the theme of innovation for building climate resilience, 'If we want a resilient world, we need to start with resilient data' (ranked 20th), by Dawn Wright, Chief Scientist at Esri, advocates innovative ways of using pre-existing climate and environment data to increase climate resilience. The author highlights the development of use cases to demonstrate how and why specific data can be used, with an emphasis on practical real-world outcomes. She links this to the use of storytelling as a valuable tool to disseminate and translate academically generated knowledge to mainstream society in ways that resonate and inspire action. The blog post also suggests the use of 'story maps' that feature data, photos and videos within the framework of a digital map.

'Both blog posts highlight the dominant focus of funding on response and recovery and the deficit in relation to reducing and managing risks.'

2.3 Urban resilience

The most popular theme through the blogs is urban resilience, with seven blog posts focusing on this specifically and many other posts touching on it. Of these seven blog posts, six discuss different aspects of the 100 Resilient Cities (100RC) initiative launched by the Rockefeller Foundation in 2013. 'The rise of resilience planning' (ranked 8th) by Julian Spector discusses the initiative's funding of chief resilience officers who work full time within city governments to incorporate resilience thinking into their strategic plans and everyday working. The blog post highlights the political risk associated with large resilience projects that span sometimes a decade or more and therefore

Bangladesh firefighters train on collaborative search and rescue operations, Bangladesh. Photo: Oregon National Guard, 2013.

multiple political cycles. It argues that the key to minimising these political risks is to develop resilient designs with community input and strong stakeholder buy-in.

'Boulder's essential green: Moving beyond concrete as a strategy for resilience' (ranked 10th) looks at how the 100RC platform and the chief resilience officer of the city of Boulder, Colorado, partnered with DigitalGlobe to use satellite imagery to gain an accurate picture of citywide tree coverage. This information on tree location and coverage allowed the city to plan active management strategies to strengthen the city's resilience. As the project included training in using the data and software for understanding and mapping tree coverage, the blog post describes managers as being more able to take advantage of the data to safeguard and leverage the city's green infrastructure. Another example of a city under the 100RC initiative is Vejle in Denmark. 'More than just a flood defence: How Vejle built a blueprint for resilience' (ranked 7th) describes how the city's flood resilience has been achieved through a process of co-creation that called for collaboration between the municipality and citizens and allowed citizens to take ownership of services and create self-sustaining communities. This participatory approach reflects the suggestions for overcoming political risks outlined in 'The rise of resilience planning' blog post mentioned above.

Two further blog posts focus on social inclusion issues surrounding urban resilience and the Rockefeller Foundation's 100RC initiative. 'Coastal cities look to resilience chiefs to combat climate change' (ranked

11th) discusses resilience chief officers in US cities funded by the 100RC initiatives. The post highlights the need for holistic urban resilience planning that not only encompasses resilient infrastructure projects but also addresses social inequalities endemic in many areas of large cities such as New Orleans and New York. Also focusing on social inclusion but in the context of informal settlements in developing countries, 'Unlocking urban resilience through innovative partnerships' (ranked 12th) discusses the Amplify Urban Resilience Challenge and the winning innovative solutions to resilience challenges in the Sahel, Horn of Africa and South/South-East Asia. The competition is described as an opportunity for people deeply rooted in their local context to make connections, be exposed to new ideas and receive feedback on their initiatives. Many of the winning resilience innovations included aspects of social inclusion and community development.

The final two blog posts describe lessons learnt from Hurricane Sandy in New York and the implications of international climate policy for urban resilience. 'Building climate resilience in cities: Lessons from New York' (ranked 21st) highlights three main lessons from the response to Hurricane Sandy: 1) good-quality climate data is available and there is no reason to delay climate action planning; 2) it is vital to plan across whole metropolitan regions and encompass the entire 'infrastructure-shed' of the city; and 3) there is a need for more cooperation and collaboration between decision-makers, infrastructure managements, citizen groups and other key actors. The post also highlights the importance of cascading impacts in the aftermath of a hurricane, with damaged loading docks, refineries and pipelines leading to gas shortages resulting in limitations for ambulances, utility workers and relief workers. The final blog within this theme, 'Climate resilience must be a global priority' (ranked 15th), argues that provisions within the Paris Climate Agreement for building urban climate resilience were not sufficient and that urban areas in particular should be focusing on building resilience as a fundamental solution to a changing climate that is going to occur with or without mitigating greenhouse gas emissions. The post presents examples of successful early warning systems developed through the Asian Cities Climate Change Resilience Network and the 100RC initiative. Examples include monitoring water levels in Hat Yai, Thailand, hydrology and land-use models in Quy Nhon, Vietnam, and passive ventilation and cool roof design innovations in Surat, India.

2.4 Finance for resilience

Four of the 25 resilience blog posts fall under the theme of finance for resilience, focusing mainly on the need for increased and more strategic use of investment for building resilient communities and infrastructures. 'A coalition for greater impact: 1 billion people on the path to resilience' (ranked 4th) presents the One Billion Coalition for Resilience, which is made up of a coalition of individuals, communities, companies, international organisations and governments working towards strengthening community resilience. The blog post highlights the need for increased partnership platforms at local, national and global levels based on common approaches and reporting models. It also argues that investment should be channelled through local and national actors before, during and after a crisis, as they are the best placed to understand the needs and vulnerabilities of the communities they belong to. The blog post 'Making climate resilience a core part of city development' (ranked 9th) also notes the need for community involvement and the full integration of resilience into city planning in order to maintain the city's social infrastructure and economic integrity. The post also highlights the large gap in financing for sustainable resilient infrastructure and the need for more innovative sources of capital.

Two other blogs answer this call for innovative sourcing of finance for resilience. 'Rising tides: Debt-for-nature swaps let impact investors finance climate resilience' (ranked 16th) presents a method of debt restructuring to free up finance for conservation and ecosystem-based adaptation to climate change in the Seychelles. 'Investing in resilient infrastructure before disaster hits' (ranked 22nd) presents a recent proposal by the US Federal Emergency Management Agency (FEMA) to create a Disaster Deductible Program, which requires recipients (i.e. state, tribal and territorial governments) to show they have dedicated a predetermined amount of finance to disaster recovery

'...investment should be channelled through local and national actors before, during and after a crisis, as they are the best placed to understand the needs and vulnerabilities of the communities they belong to.'

before FEMA provides any financial assistance, thereby incentivising local governments to invest in risk reduction activities and projects.

The four blog posts under the theme of agriculture, biodiversity and resilience focus mainly on innovative research, initiatives or strategies to build agricultural and community resilience. 'From homogenous to indigenous: Investing in native food systems for a resilient future' (ranked 6th) presents Indigenous Terra Madre, a global platform for the promotion of indigenous and locally based agro-ecological food systems and a space for the collaboration of farmers, philanthropists, entrepreneurs, chefs and policy-makers. The post highlights the role of chefs in preserving the diversity and indigenous knowledge of wild and traditionally cultivated foods, flavours and culinary techniques as well as the role of biodiversity in human health. It also highlights the need to bring back underutilised food crops and promote polycultures rather than monocultures, giving as an example the re-emergence of millet as a nutritious, indigenous and drought-resistant food crop. Indigenous peoples are presented as the agents for this change, who can use their unique knowledge and capacities to mitigate or reverse the damage caused by climate change and unsustainable development. It also argues the need to preserve not only biodiversity but also the cultural diversity of indigenous peoples and their right to govern their own territories.

Touching on innovation and participation themes, 'From disaster victims to frugal innovators: Learning from communities how to build resiliency' (ranked 14th) presents a BRAC and UN Development Programme (UNDP) initiative to establish disaster-resilient housing in Bangladesh. Innovative options such as tile-covered houses elevated on pillars were explored to protect those living in exposed coastal areas. The post notes that the success of the project is owed in a large part to the community taking ownership of, maintaining and even improving their houses, asserting that communities are not just recipients of aid but also agents of change. Linked to this idea of individual agency and household solutions, 'Climate change gardening – building resilience from the ground up' (ranked 13th) describes an innovative more resilient form of gardening that discourages digging; the plants are grown in a thick layer of compost that is laid on top of the ground. The blog post argues that this method of gardening allows the land to deal with flooding and drought in a much more effective and natural way. It also highlights in particular the role of mycorrhizal fungi, which, when left in undisturbed ground, can enable plants to find and absorb water, thereby reducing the chances of waterlogging and floods.

The fourth and final blog under this theme presents an innovative and exciting piece of research that may change the way we measure and build resilience. 'Researchers find the tipping point between resilience and collapse in complex systems' (ranked 5th) presents the work of Albert-László Barabási and his colleagues Jianxi Gao and Baruch Barzel, who used statistical physics to develop a tool to identify the tipping point from resilience to collapse in a variety of complex systems. The blog post presents as an example the

Building more resilient communities, Philippines. Photo: European Commission DG ECHO, 2009.

symbiotic relationship between different species of ants and plants and displays how the tool can simulate the relationship between the two and the minimum number of ant species required to avoid a complete collapse in the plant ecosystem and vice versa. It highlights the implications of this research for agricultural resilience planning in terms of preserving key species of bee for example, but also for communities and infrastructure resilience, as the tool is able to determine the tipping point of complex human and technological systems.

2.5 Conflict and resilience

Three of the blog post focus on conflict and resilience, highlighting the ability of conflict to compound risk from other sources such as disasters and the need for better management to reduce these and other associated risks. 'Fragility, conflict, and natural disasters – a "one-size fits all" approach to resilience?' (ranked 24th) notes that more than half of people affected by natural hazards live in fragile and conflict-affected states (FCAS) and that conflict can increase vulnerability to natural disasters because weakened state structures are less prepared for response and recovery, communities are less resilient and people displaced by conflict and violence are more exposed to disaster risk. The post presents a Global Facility for Disaster Risk Reduction (GFDRR) initiative to share lessons and develop guidance and tools that acknowledge and respond to the dynamic relationship between conflict, fragility and disasters, with the goal of strengthening the institutional ability to inform interventions in fragile contexts, conflict analysis and recovery and resilience-building in areas at risk of disasters.

Taking a more sector-specific approach, 'Pathways to resilience: Evidence on links between conflict management, natural resources, and food security' (ranked 19th) presents the conclusions of a Mercy Corps report on conflict management in the Horn of Africa. The report found that, as household food security is heavily affected by climate-related shocks and continued conflict, natural resource management (NRM) is crucial to mitigating conflict and increasing food security. The post presents examples of areas where the perceived ability to negotiate the sharing of natural resources has led to more dietary diversity and lower prevalence of unsustainable coping strategies such as borrowing food. However, it also highlights the difficulties in scaling up these specific examples, although it notes that programmes designed around natural resources have positive impacts on governance, food security and conflict.

A third blog post, 'Rebuilding societies: Strategies for resilience and recovery in times of conflict' (ranked 23rd), presents another report that discusses the on-going refugee crisis in the Middle East. The report provides three considerations for international organisations when responding to challenges facing refugees and asylum seekers: 1) improvements in the way international aid agencies interact with local actors

A vegetable garden on the bank of a fish and rice pond, Bangladesh. Photo: Mike Lusmore/Duckrabbit, 2012.

are required, including taking into account local actors' capacities and requirements; 2) longer-term and deeper support is required for countries and communities hosting large numbers of refugees; and 3) donor countries need to demonstrate political leadership by sharing the refugee burden and investing in supporting these communities.

2.6 Gender and resilience

Two blog posts discuss how women are incorporated or involved in disaster risk management (DRM) and resilience-building. 'The growing role of women in disaster risk management' (ranked 25th) discuses women's participation in DRM in coastal India. It attributes the success of Odisha's evacuation prior to Cyclone Phaillin in 2013 in part to equal access to information and skills for women, which increased the capacities of individual women and the community as a whole. The post also notes that, by creating space for women in decision-making, communities and states are given the opportunity to benefit from and utilise women's unique potential in mitigating and managing disasters. This argument is echoed in the second blog post, 'UNICEF, FAO, WFP Joint Resilience Project (JRP): Empowering women empowers communities' (ranked 18th). The JRP aimed at increasing resilience by addressing the effects of flood and drought shocks on the health and nutrition status of women and children in eastern Sudan. The post highlights that, once traditional barriers to women and children's health, such as cultural stigma around women seeking medical help outside the home, have been overcome, there are significant advances in many aspects of health. Women also gained the knowledge and confidence to protect their households and communities from food- and health-related shocks. Both blog posts discuss the agency and capacity of women to be drivers of resilience and risk reduction within their communities and highlight the importance of supporting women in realising this potential.

'Both blog posts discuss the agency and capacity of women to be drivers of resilience and risk reduction within their communities and highlight the importance of supporting women in realising this potential.'

3. Resilience in the grey literature

Our examination of papers on resilience published between April and June 2016 includes 36 from research and private sector institutions, donors and multilateral agencies. These span six broad themes: agriculture, livelihoods and food security; gender equality and social inclusion; urban resilience and cities; financial inclusion and markets; approaches to resilience; and engagement with post-2015 processes. The increase in the amount of work on post-2015 processes reflects an uptake of the major policy frameworks agreed in 2015, including the Sustainable Development Goals (SDGs), the Sendai Framework and the Paris climate change agreements.

3.1 Agriculture, food security and livelihoods

Grey literature on agriculture, food security and livelihoods suggests:

- There is a need for increased public and private agricultural investment that specifically targets smallholder farmers and women.
- There is a need for improved NRM and biodiversity protection, which is vital for building resilient agricultural value chains.
- Livelihood diversification does not necessarily result in increased resilience, particularly in areas with a lack of high-return on non-climate-related livelihood activities.
- There is a need for an integrated cross-sectoral approach to augmenting weather and climate information systems.
- Successful and resilient food supply chains feature flexible actors and diversified sources of crops; enhanced resilience requires the integration of the value chain approach and climate risk management (CRM) practices within broader policies and systems.

Seven papers in the grey literature focus on building resilience in the agriculture and food security sectors. The majority argue for increased investment and resilience-building efforts, with a particular focus on smallholder farmers and women. Two papers describe the impacts of El Niño on food markets and production around the world, and building household resilience to these climate-related shocks (Dorosh et al., 2016; Oxfam, 2016b). Two papers discuss resilience within agricultural value chains, drawing on case studies of Shea in Burkina Faso (Venturini et al., 2016) and rice in Uganda (Daze and Dekens, 2016); another paper discusses disruptions in food supply chains with a particular focus on shocks in Association of South-East Asian Nations (ASEAN) countries (Reddy et al., 2016). All the papers note the importance of diversification in building resilience, whether it be in diversifying material sources to protect supply chains, livelihoods to protect incomes or investments to enhance outcomes.

Venturini et al. (2016) conducted a climate-resilient value chain analysis of Shea production and trading in Burkina Faso. They call for initiatives that benefit both economic development and CCA, including through NRM and biodiversity protection; enhancing the role of non-governmental organisations (NGOs) and national research centres in the development of a competitive Shea value chain; improving weather and climate information systems; enabling the equitable participation of women in the Shea value chain; and incentivising private sector investment.

In their briefing note on the rice value chain in Uganda, Dazé and Dekens (2016) propose a framework of core functions for CRM along agricultural value chains. The authors highlight the role of service providers in supporting CRM, noting that diversified supply sources are likely to have more assets to buffer against shocks and stresses. Three core functions for all agricultural value chain actors will build resilience: 1) climate risk assessments; 2) adaptive management; and 3) responding to shocks. The briefing stresses the role of climate information services, financial services, market information systems and infrastructure in underpinning the implementation of core CRM functions.

Reddy et al. (2016) examine the factors that amplify or avoid food supply chain (FSC) disruptions in the case of 'natural' disasters and extreme weather events. A resilient FSC is less likely to be disrupted by internal or external factors, and is therefore more capable of recovering quickly from a disruption or shock. Case studies from Asia suggest government policies must focus on supporting small-scale producers, farmers and agribusinesses' continuity plans, alongside the provision of critical resilient infrastructure, subsidies and compensation after a disaster occurs. Reddy et al. also note the importance of ASEAN countries in global merchandise trading and highlight the need for transparent and uncomplicated official procedures and policies so as to enhance mutual respect among actors across the supply chain.

Two papers tackle the impacts of the current El Niño on agriculture. Dorosh et al. (2016) present policy measures and recommendations to enhance the resilience of cereal production and food markets, which include increased targeted safety net programmes; reduced restrictions on domestic trade; encouraging international trade; small, timely and transparent interventions in domestic markets through public stock sales; and investments in agricultural research. The Oxfam (2016b) briefing on the impacts of the recent El Niño in Southern Africa and Ethiopia calls for measures to target those most vulnerable, especially women and smallholder farmers. The authors highlight the trend of governments and donor agencies investing in large PPPs, such as GROW Africa and the New Alliance for Food Security and Nutrition. They warn that these 'mega-PPPs' divert investments away from public spending on agriculture, promote unsustainable and ecologically damaging solutions and result in the marginalisation of smallholder farmers, thereby increasing the vulnerability of rural communities and entrenching inequality in these areas.

The Food and Agriculture Organization (FAO) (2016a) highlights four methods of addressing different shocks that threaten agricultural livelihoods: 1) crisis and disaster risk governance to protect against multi-hazards at different levels, such as supporting appropriate and enabling policies, institutional structures, capacities and financing for DRR and crisis management; 2) crisis and disaster risk monitoring and early warnings, coupled with timely alerts, which the authors suggest will support accurate decision-making at the institutional and community levels; 3) prevention and vulnerability reduction through the application of risk-sensitive technologies, good practices, risk transfer and social protection; and 4) emergency preparedness and response to help people become self-reliant and productive again after a shock or stress. The paper recommends policies that increase assets and access to credit for women, as evidence demonstrates that female-headed households are more efficient at allocating budgets for food consumption, despite having predominantly less access to services and higher vulnerability to shocks and stresses.

'The paper recommends policies that increase assets and access to credit for women, as evidence demonstrates that female-headed households are more efficient at allocating budgets for food consumption, despite having predominantly less access to services and higher vulnerability to shocks and stresses.'

Nelson et al. (2016) draw on data and experiences from the Pastoralist Areas Resilience Improvement and Market Expansion (PRIME) and Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED) programmes in arid and semi-arid lands

Irrigation improves food security, but must be done fairly, Ethiopia. Photo: Beatrice Mosello/Overseas Development Institute, 2014.

(ASALs) in the Horn of Africa. Both sets of data show that livelihood diversification does not always have a positive influence on recovery and adaptation. The areas that showed no significant positive relationship were areas with lower availability or opportunity for pursuing non-climate-sensitive livelihoods. They recommend that the strategy of livelihood diversification as a singular mechanism to cope with shocks and stresses needs to be considered within the specific contexts in which projects are being implemented.

3.2 Urban resilience

Grey literature on urban resilience suggests:

- Women are particularly vulnerable to climate risks in urban areas given their increased engagement in climate-sensitive livelihoods and lack of information and opportunities for participation in decision-making processes.
- Effective promotion of urban DRR combines financial and non-financial incentives that are specifically tailored to the capacities and requirements of the area.
- Access to affordable climate-resilient housing can be enhanced through the provision of context-specific and appropriate mortgages and microfinance mechanisms.

Of the four papers that focus on urban resilience, three highlight the need for financial mechanisms and incentives for building resilience and promoting DRR in urban contexts (Dieu, 2016; Singh and Singh, 2016; ADB, 2016). Both Dieu (2016) and Singh and Singh (2016) highlight the importance of appropriate microfinance and mortgages as a means of building resilience through supporting women's livelihoods and the generation of climate-resilient housing. Papers also note the importance of developing capacity and skills to build climate-resilient housing and water and sanitation facilities (Singh and Singh, 2016; Alam et al., 2016). The need for improved public participation runs through all the papers as a crucial element of the planning and resilience-building process in urban contexts.

Dieu (2016) discusses the importance of gender roles in building resilience at the household level. Evidence from Hue, Vietnam, shows that women play a larger role than men in sustaining and enhancing people's health and well-being, as well as in accruing funds for households and communities. Women are more likely to be engaged in climate-sensitive livelihood activities, even though they are in general less informed about climate change and DRR and have less of a voice in public and political life. The authors suggest that institutions create more opportunities for learning and for female participation in climate-resilient planning and practice.

Singh and Singh (2016) find lack of appropriate and context-specific mortgages and financial services is the main reason low-income families have little access to affordable resilient housing. The paper therefore argues for the scaling-up of microfinance schemes and an increase in capacity and skill-building efforts for climate-resilient building. Government policies can facilitate these two measures by providing smart subsidies, planning, PPPs and technical assistance. A World Bank (2016a) paper under Section 3 of this scan ('Frameworks and organisational approaches') further highlights this need for climate-resilient housing by discussing the multiple issues surrounding the development and implementation of appropriate building regulations.

An Asian Development Bank (ADB) (2016) paper draws on experiences from case studies across Vietnam, Nepal and the Philippines in order to discuss financial and non-financial incentives for urban DRR. Financial incentives take the form of grants, tax credits, subsidies, discounts on insurance premiums and cash transfers. Non-financial incentives include awards, access to information and technology and so on. While financial incentives were most often identified, the most effective use of incentives combined financial and non-financial measures. The case studies suggest acceptance of incentives (believing it will work) and participation in decision-making (public consultation) underpin any successful incentive for reducing disaster risk in urban areas.

In contrast with the other papers, which highlight financial aspects of building urban resilience, Alam et al. (2016) identify mainly management and policy recommendations to remedy a lack of sufficient and climate-resilient water and sanitation services. The authors suggest the following measures: increased management of waterlogging and flooding, including the provision of a comprehensive city-wide mapping study; ensuring an adequate supply of water through deep tube wells to reduce arsenic and salt water intrusion; ensuring adequate drainage and sewerage facilities; providing sanitary latrines; and improving solid waste management.

3.3 Measuring resilience

Grey literature on measuring resilience suggests:

- There is a need for a clearly defined and tested 'menu' of indicators of resilience that cover a range of different sectors/topics and types of outcomes and impact.
- Use of the term 'resilience' has increased exponentially over the past 10 years across policy, social media and academia.
- When measuring resilience, capacities beyond demographic and economic factors must be considered (i.e. human capital, social networks and subjective measures of shock impact).
- There is a need for increased time series data in order to observe and determine the effects of long-term vs. short-term coping strategies and their consequences for resilience.

'There was a nine-fold increase between 1997 and 2015 in the use of the term 'resilience' in published items across the Web of Science research platform'

Of the six papers that look at measuring resilience, two present and evaluate a new FAO model for measuring resilience (FAO, 2016b, 2016c) and two others draw on case studies to recommend improvements to methods for measuring resilience (Bower et al., 2016; Williams, 2016). In a further layer of complexity, one paper discuses not only the means of measuring resilience but also the method by which these means are being assessed and evaluated (Constas et al., 2016). Moreover, two of the papers echo authors from other sections (particularly Section 3.4 on Social aspects of resilience) by highlighting the role of subjectivity in measuring impacts and resilience (Bower et al., 2016; Constas et al., 2016). Notably, three papers underline the need for clear and coherent definitions on resilience in order to meaningfully measure it.

Lovell et al. (2016) present the latest trends and themes in the use of the term 'resilience' across grey literature, academic literature and social media. There was a nine-fold increase between 1997 and 2015 in the use of the term 'resilience' in published items across the Web of Science research platform, and Google searches for 'resilience' doubled between 2004 and 2015. The paper highlights the prominence of the term 'resilience' in the post-2015 international frameworks on DRR, sustainable development and climate change. The authors attribute this to the concepts' ability to break down the boundaries of different institutions, sectors and disciplines, alongside the positive connotations associated with the word. The most prominent themes

Farmers in Western Kenya. Photo: C.Schubert, 2014.

on resilience since 2015 have been 'governance, institutions, policy and planning' in academic literature and 'operational approaches to building resilience' in grey literature. Over 71% of the papers reviewed come from academic literature or journals published in industrialised countries, suggesting greater efforts are needed to promote the study of, and publication on, resilience in the Global South.

Bower et al. (2016) draw on results and methodologies from the PRIME and BRACED programmes to distil key factors that contribute to their successful monitoring of resilience and shocks. These include 1) on-going monitoring of people's ability to respond, as well as the impacts of shocks and stresses, changes over time; and 2) measurement of shock impacts to include both objective and subjective measures: objective data to avoid possible distortion of subjective data, and subjective data to assess and validate perceived impacts. This latter call is supported by papers by both Woodson et al. (2016) and Hallegatte et al. (2016) (see Social aspects of resilience, Section 3.4), which further highlight the role of social capital and inequality in measuring and building resilience. Results from baseline surveys show that absorptive, adaptive and transformative capacities commonly used to measure resilience are indeed positively related to household recovery from different types of shocks, particularly drought and food price shocks. Bower et al. also highlight the risk of data distortion through the under-reporting of the severity of a shock, or as a result of people over-reporting so as to receive more aid.

Constas et al. (2016) provide a transparent, accessible review framework to assess methodologies for resilience measurement. Four key components to review are 1) the conceptual presentation of resilience (definition and types of resilience noted); 2) resilience indicators (properties of measurement – temporal, objective, subjective and qualitative); 3) study design features (location and sample size); and 4) analytical procedures (estimation procedures and the study of resilience dynamics). The authors note that only two of the four articles/measurement methods reviewed include resilience capacities that go beyond demographic and economic factors to incorporate human capital and social networks. The report highlights the need to assess the dynamics between shock exposure, well-being, capacities and path or time dependencies.

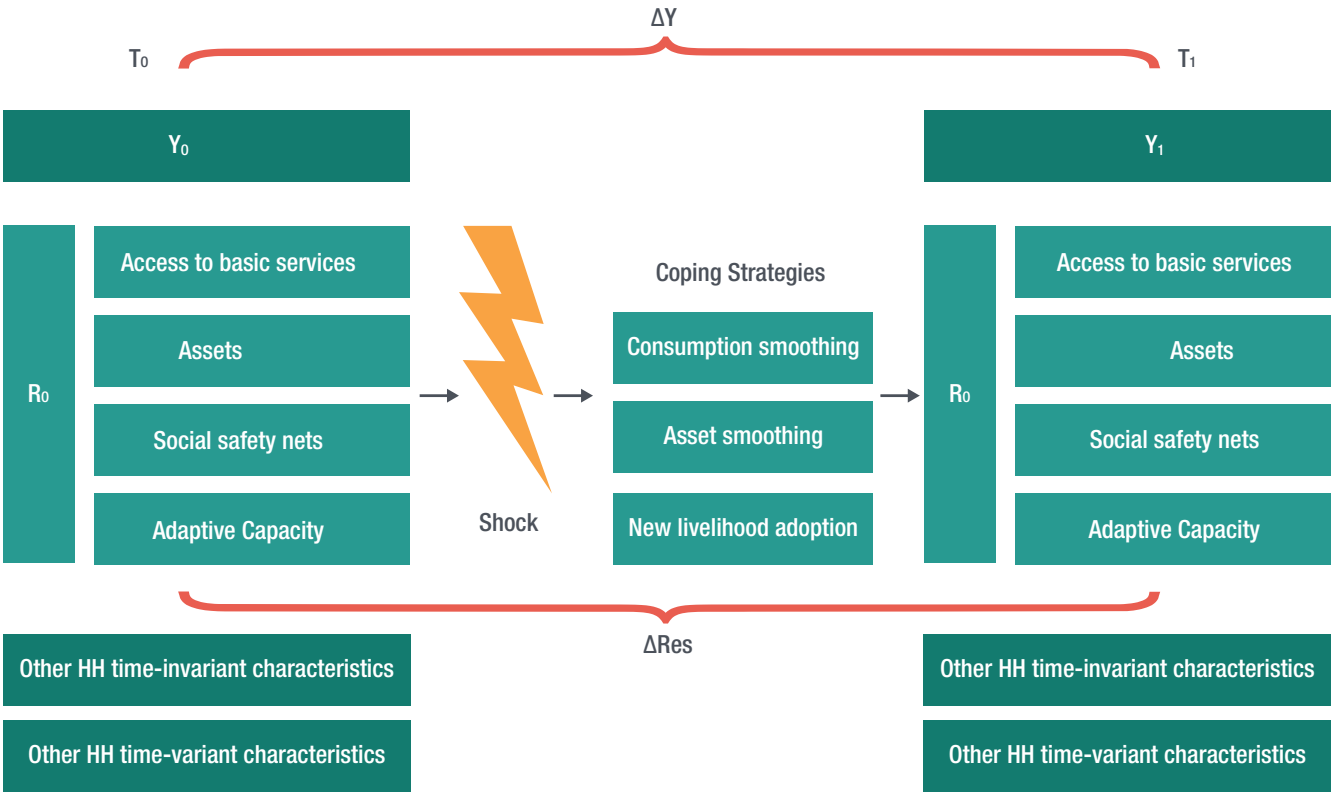
Williams (2016) draws on recent work on climate and disaster resilience monitoring and evaluation (M&E) and identifies good practice. The author highlights that 1) 'wicked' problems (i.e. climate change) require creative adaptive solutions; 2) methodological challenges include establishing clear baselines, identifying common indicators, setting realistic and stable targets and identifying long-term impacts; and 3) the field is young and learning from experience. She recommends the use of comparable definitions of resilience and the development of a 'menu' of clearly defined and tested set of indicators that cover a range of different sectors/topics, and types of outcomes and impact for measuring resilience.

'...there is a need for policy interventions to increase income-generating activities, access to public electricity networks, availability of safe toilets and the provision of food.'

FAO (2016b) uses the Resilience Index Measurement and Analysis (RIMA)-I model (precursor to the RIMA II) to determine resilience in the Republic of Sudan. The model used a sample of 7,915 households and found that, in the areas of Kordofan and Darfur, there is a need for policy interventions to increase income-generating activities, access to public electricity networks, availability of safe toilets and the provision of food. The paper also emphasises the need for policies that improve technologies and investment in irrigation schemes for sustainable agriculture and increased asset endowment and access to credit for female-household heads.

RIMA-II represents a radically different analytical framework from RIMA-I and contains direct and indirect methods for measuring resilience, focused on food security (FAO, 2016c). RIMA-II's analytical framework (see Figure 1) contains four fundamental pillars of resilience made up of multiple indicators that should be considered before and after a shock. These pillars are 1) access to basic services; 2) assets; 3) social safety nets, including both formal and informal transfers; 4) sensitivity (considered exogenous to the model); and 5) adaptive capacity. Direct methods of measuring resilience provide a more descriptive tool, whereas indirect methods allow for greater statistical inference of the main determinants of resilience. The paper also highlights the need for increased time series data in order to determine the effects of long-term vs. short-term coping strategies and their consequences for resilience.

Figure 1. RIMA-II resilience conceptual framework (FAO, 2016c) (where Y = food security and R = resilience over time t)



3.4 Social aspects of resilience

Grey literature on social aspects of resilience suggests:

- There is a need to include psychosocial factors and subjective measures in theories of change and measurement, alongside more tangible variables, in order to build an understanding of what factors contribute to resilience at different levels.
- Social capital has a significant positive relationship with variables that indicate resilience.
- Greater equality is a major driver of higher resilience.
- There is a need for increased investigation into the appropriate location for subjectivity within resilience measurement research.
- Underlying inequalities can be tackled through gender-sensitive strategies that recognise the interests, capacities and power relations between women and men.

Of the seven papers discussing social aspects of resilience, two look at the influence of subjective and psychosocial factors on people's resilience (Béné et al., 2016; Jones and Samman, 2016). Three others focus more on the influence of social capital and socioeconomic factors (Woodson et al., 2016; Hallegatte et al., 2016; Sridarran, 2016). The common observation in these papers is that our traditional understanding of the determinants of resilience based on objective and tangible variables does not apply in all cases and at all levels. This shift away from objective measurements of resilience towards more subjective approaches is also relevant to the Measuring resilience section.

Woodson et al. (2016) draw on empirical evidence from four different programmes focused on measuring resilience: PRIME, the PRIME Interim Monitoring Survey (IMS), BRACED and Resilience in the Sahel-Enhanced (RISE). The analysis suggests that social capital (networks, membership of groups, social relations, access to wider institutions in society) has a positive effect on food security, helps households recover from shocks and mitigates the effects of shocks across the different datasets. However, the PRIME IMS also suggests such social capital can be used up in the early phases of a prolonged covariate shock and thus is not a panacea for building resilience. The paper concludes by highlighting the need for more effective indicators for monitoring social capital and the ways households use it over time.

Hallegatte et al. (2016)'s flood model shows welfare losses from the 2005 Mumbai floods were twice as large as asset losses in part because of the over-exposure and vulnerability of poor people in the city. The model provides policy options that were geared towards either reducing welfare losses by reducing asset losses (i.e. flood zoning, improved asset quality) or reducing welfare losses directly through increased post-disaster support (i.e. increasing diversification, improving access to savings). Notably, the results of the policy analysis show there is no trade-off between poverty reduction and risk management. They find that, when poverty decreases, even if there are increased asset losses during a shock, net welfare is positive, as people are better able to cope with asset loss. The analysis finds that higher equality is a major driver of higher resilience, suggesting a greater focus on welfare rather than asset loss.

Sridarran et al. (2016) draws on case studies from Sri Lanka to discuss the resilience of displaced and host communities in the case of internal involuntary displacement. Unsurprisingly, the authors observe that the resilience of displaced communities often decreases after displacement, owing to loss of assets and social structures/systems. Government relocation based on top-down regulations with no community consultation resulted in pressure on common resources, mismanagement of assistance and benefits and friction between the displaced and the host communities. Acknowledging the constraints of urgency and lack of resources, the authors recommend greater community participation and consultation when people are being displaced.

Both Béné et al. (2016) and Jones and Samman (2016) discuss psychosocial factors, subjectivity and perception in the context of resilience. Béné et al. develop a conceptual framework that includes psychosocial factors such as aspiration, risk aversion and self-efficacy, and consider their translation into the perceived ability of people to handle shocks and stresses. Analysis from Ghana, Fiji, Vietnam, Sri Lanka and Ethiopia confirms that psychosocial factors strongly determine the types of responses and capacities (absorptive, adaptive or transformative) people demonstrate in the immediate aftermath of an adverse event. Jones and Samman's nationally representative survey finds that low resilience-related capacities are a concern in Tanzania. Interestingly, subjective measurements of resilience do not match more objective criteria such as age, occupation, wealth status and place of residence. The authors suggest this could be either because common objective characteristics do not have a strong influence on perceived household resilience or because a subjective approach to assessing household resilience is a poor representation of overall resilience. Like Béné et al., this reflects the need for increased investigation into the appropriate location for subjectivity within resilience measurement research.

'Interestingly, subjective measurements of resilience do not match more objective criteria such as age, occupation, wealth status and place of residence.'

Kratzer and le Masson (2016) draw on empirical evidence from case studies in Peru, India and Kenya to determine 10 key messages for achieving gender-sensitive climate-compatible development (CCD). These messages include the importance of recognising people's different needs; differences in gender dynamics in urban and rural locations; that gender equality must be an explicit goal and address power imbalances and unequal decision-making; and that M&E of gender outcomes is vital. They highlight the key drivers of commitment, policy and skills. The All India Disaster Mitigation Institute (AIDMI) (2016) also calls for increased empowerment of women and children, in order to build resilience in the Indian state of Assam. The paper highlights the need for greater integration of DRR and CCA; increased assessments, capacity and coordination; and access to risk and preparedness information.

3.5 Finance and social protection

Grey literature on finance and social protection suggests:

- There is a need for new and improved approaches and increased funding for DRR interventions in FCAS.
- 'Responsive social safety nets' are conventional social safety nets with built-in mechanisms that allow existing programmes to be scaled up after a disaster.
- Social protection initiatives are most able to contribute to climate resilience when they are flexible, scalable, long term and highly climate-responsive.

Four papers in this scan focus on social protection, with two others examining microfinance and disparities in international DRR finance. All four papers on social protection cite flexibility, scalability, cross-sector coordination and adequate information and finance

as requirements for social protection/social safety net initiatives to be effective in building resilience.

A World Bank (2016) report discusses the scaling-up or fast introduction of social safety nets in order to minimise the impacts of 'natural' disasters and man-made conflicts. Additionally, the paper presents evidence to support the use of social safety nets in building resilience at the household level through cash transfers, food and public works transfers. Despite some positive evidence, it demonstrates that social protection systems are present in most middle-income countries but are lacking in the low-income countries (particularly in sub-Saharan Africa) where they are needed the most. The paper describes the main building blocks required for the effective establishment of a 'responsive social safety net': flexible delivery systems; interoperable information systems; predictable financing for contingent liabilities; ex-ante coordination mechanisms; and capacity investments.

Wallis and Buckle (2016) and Williams et al. (2016) take different approaches but cover similar issues, with both noting the importance of inter-institutional coordination and integration. Williams et al. draw on country examples from small island developing states to develop some key guiding principles in relation to the use of social protection programmes. These include the need for transparency, fast delivery mechanisms, clarity on rules and eligibility, promotion of livelihood diversification and the need for specific short-term social insurance schemes to support disaster response. Wallis and Buckle note that social protection initiatives are most able to contribute to climate resilience when they include climate vulnerability assessments in targeting, have scalable and flexible shock mechanisms and operate long term. Ulrichs (2016) expands these arguments, presenting the three functions of social protection – prevention, protection and promotion – as contributing to the three resilience capacities – anticipatory, absorptive and adaptive. The paper echoes the three papers above in highlighting the need for scalable and flexible social protection programmes alongside adequate information management, finance and cross-sector approaches.

In relation to microfinance, VisionFund (2016) examine the impact of its Community Economic Ventures Incorporated initiative on household economic recovery following Typhoon Haiyan in the Philippines. A total of 96% of clients reported that the loans received had helped support rapid client recovery within 20 months of the disaster. Recovery lending was affordable, with both on-time repayment rates and write-off ratios deemed better than average, while microfinance institutions were able to cover their costs with interest and did not experience abnormal credit risk. Greater preparation before disaster events will optimise the speed and effectiveness of recovery lending in the future.

Finally, Peters and Budimir (2016) present figures on finance for DRR and CCA in FCAS as well as provide recommendations for the role of the post-2015 international frameworks and the wider DRR international community to increase DRR interventions in FCAS. Despite the 58% of disaster deaths and 34% of people affected by disasters occurring in FCAS between 2004 and 2014, only $1.30 of every $100 spent on humanitarian response is spent on DRR. The authors highlight the need to better understand the impact of multiple hazards and their interactions, as well as the complex web of vulnerabilities, risk, exposure, hazards and capacities present in FCAS.

3.6 Frameworks and organisational approaches to resilience

Grey literature on frameworks and organisational approaches to resilience suggests:

- Frameworks must be coordinated, integrated and flexible in order to support a multitude of contexts.
- Development and implementation of construction/building regulations are required to address underlying risk in built environments.
- Flood early warning systems (FEWS) must be end-to-end and include risk knowledge, risk monitoring, communication and dissemination, and support people's ability to respond to a flood event.

Seven papers in the grey literature focus on frameworks and organisational approaches to building resilience. Three of these present their respective organisational frameworks for building resilience (Oxfam, 2016a; Pasteur and McQuistan, 2016; UN, 2016). The rest of the papers provide a discussion on the means and methods for developing organisational approaches to resilience (ADRRN, 2016; GFDRR, 2016; Sugden, 2016). There are a number of cross-cutting themes within these papers, with many advocating that effective frameworks for building resilience are not possible without being context-specific and cross-sectoral and taking an integrated approach. Additionally, two papers mention the need to strengthen construction and building regulations and practices as a means of

managing underlying risk (GFDRR, 2016; World Bank, 2016a).

The Oxfam (2016a) framework uses a gender, systems and process-oriented approach, while taking into account social and environmental limits. Resilience outcomes require strengthening adaptive, absorptive and transformative capacities via four different pathways: 1) working collaboratively with multiple stakeholders, marginalised and vulnerable people and civil society; 2) understanding the context, including local, national and global drivers and impacts of risk, fragility and vulnerability; 3) preparing and designing programmes that take a long-term approach; and 4) learning iteratively and implementing on-going adaptive management for flexible, timely and appropriate interventions that can be adapted to the changing contexts and impacts of the programmes.

Practical Action's Vulnerability to Resilience framework (Pasteur and McQuistan, 2016) comprises four interrelated components in a dynamic and evolving system: 1) understanding and adapting to future uncertainty; 2) effective responses to shocks and stresses; 3) good governance; and 4) livelihoods security with investments for the future. The framework measures five core capitals (human, social, natural, physical and financial) before and after a disaster in order to observe how development, disasters and DRM activities can limit or support well-being within a community. The paper discusses issues around measuring resilience, highlighting the diversity and complexity of factors to be monitored.

'This paper highlights the challenge of communication and dissemination. For instance, in Nepal information was passed on via mobile phone numbers, which were a challenge to keep updated. The authors stress the need for local ownership of FEWS and the sustainability of resilience gains.'

The third paper outlines the UN Plan of Action on Disaster Risk Reduction for Resilience, aimed at the international policy scale. It aims to ensure coherence and integrate climate risk and resilience into the key post-2015 international frameworks and UN system (UN, 2016). The plan comprises 11 expected results to 2020 and commitments to 1) strengthen system-wide coherence in support of the Sendai Framework and other agreements, through a risk-informed and integrated approach; 2) build UN system capacity to deliver coordinated, high-quality support to countries on DRR; and 3) ensure DRR remains a strategic priority for UN organisations. The Asian Disaster Risk Reduction Network (ADRRN) (2016) also highlights synergies and key achievements of the international post-2015 frameworks, such as the focus on dignity and equality and recognition of the inter-connectedness of risks, vulnerabilities and actions.

Another Practical Action paper (Sugden, 2016) draws on case studies from Nepal and Bangladesh to argue that FEWS must be end-to-end and include four components: 1) risk knowledge; 2) risk monitoring; 3) communication and dissemination; and 4) ability to respond. This paper highlights the challenge of communication and dissemination. For instance, in Nepal information was passed on via mobile phone numbers, which were a challenge to keep updated. The authors stress the need for local ownership of FEWS and the sustainability of resilience gains.

The World Bank (2016a) highlights that, in the past 10 years, high-income countries with more advanced building code systems have experienced 47% of disasters globally, yet accounted for only 7% of disaster fatalities. The World Bank's building regulation for resilience programme aims to help reduce human and economic losses by avoiding the creation of new risks and reducing existing risks in the built environment. This programme has four main components: 1) national-level legislation and institutions; 2) building code development and maintenance; 3) local implementation and knowledge-sharing; and 4) measurement. Similarly, GFDRR (2016) highlights the need for enhanced construction practices alongside more comprehensive and accurate methods of assessing evolving and dynamic risk. These include ecosystem-based measurements for hazard protection and the implementation and enforcement of effective land use policies.

4. Review of resilience in the academic literature

In this quarter, we reviewed 25 academic papers, of which 24 peer-reviewed papers from agriculture, DRR, development, geography, ecology and anthropology journals were retained in the final analysis. The papers span four themes: multi-scalar and cross-sectoral adaptation; power, perceptions and subjective resilience; adaptive capacity in agro-ecological systems; and migration and displacement. They indicate a move towards conceptualising resilience in the context of complex systems, particularly in the 'multi-scalar and cross-sectoral adaptation' and 'adaptive capacity in agro-ecological systems' themes. They also reflect a trend towards including the perceptions of people directly in the study of resilience, the design of resilience programmes and efforts to measure resilience. This tendency is most evident within the 'power, perceptions and subjective resilience' and 'migration and displacement' themes.

Academic literature on multi-scalar and cross-sectoral adaptation suggests:

- A legal framework with clear allocation of responsibilities for climate adaptation and resilience actions is essential to collaborate effectively.
- Private sector involvement in CCA is limited. Without a better understanding of the drivers of adoption of CCA actions by corporations and a method of evaluating outcomes, efforts to adapt to climate change will neglect the role of the multinational and large corporations.
- Focusing on the institutional conditions that foster resilience-building is as important as resilience outcomes, particularly to understand barriers for adaptation actions for local, national and regional governments.
- Understanding local institutional histories is key to add nuance to resilience scoring and measurement that relies on quantitative global and regional-level indicators.
- CCA planning should consider the vulnerability of critical infrastructure and the possible cascading impacts onto socioeconomic systems.

4.1 Multi-scalar and cross-sectoral adaptation

Eight papers grapple with issues of building resilience across scales and sectors, investigating the complex institutional, governance and corporate arrangements that can facilitate better CCA and risk governance. One key question featured in the literature is how to divide responsibilities for CCA between sectors and across scales of governance, with three papers suggesting methods of defining and allocating these responsibilities (Herslund et al., 2016; Vedeld et al., 2016; Runhaar et al., 2016). One paper presents a methodology for assessing institutional capacities for CCA at multiple scales (Termeer et al., 2016) and another compares results for projected resilience at the global and basin level, to show how a basin-scale analysis brings in important nuance to global findings (Peterson-Perlman, 2016). One study investigates the role of the private sector in adaptation decisions (Averchenkova et al., 2016), drawing attention to the extensive reach of multinational corporations and considering their potential responsibilities in CCA. Lastly, one paper examines how the resilience of critical infrastructure can have cascading impacts on the adaptive capacity of society (Pescaroli and Alexander, 2016).

Successful adaptation in social-ecological systems demands institutions capable of addressing climate challenges at multiple scales, from the global to the local level. By analysing global, European and Dutch adaptation governance, Termeer et al. (2016) investigate the clashes between the local and the global scales and how different strategies can facilitate CCA. The authors apply a framework consisting of five governance capabilities that they determine are crucial for coping with wicked problems like climate change: reflexivity, resilience, responsiveness, revitalisation and rescaling. The authors found that, at all levels, there were mixtures of strategies, but reflexive strategies were the most common, indicating an ability to

deal with problems with multiple timeframes across national, regional and global institutions. The authors explain that there can be conflicts between adaptation governance at different scales; national interests prevail in shaping adaptation policies that may not always be in line with regional priorities. Based on their pilot application of the method, the authors argue that applying the framework is useful for focusing on the process of creating institutional conditions for CCA, rather than solely on policy outcomes. In a similar study that focuses at the local level, Cuevas (2016) examines the institutional conditions that enable CCA planning. Taking Albay, Philippines, as a case study, Cuevas emphasises the interconnected nature of challenges for mainstreaming CCA and promoting adaptation actions. The paper presents a four-stage mixed methodology to assess barriers to mainstreaming CCA into local-level planning, combining institutional analysis and related quantitative indicators. It finds that resource-related challenges are important at every stage of CCA initiatives, and that improved knowledge and awareness of climate impacts incentivises planners to apply mainstreaming approaches into planning.

Herslund et al. (2016)'s paper assessing urban vulnerability to climate change in sub-Saharan Africa demonstrates that vulnerabilities at municipal and household scales are interdependent, with weak institutional capacity, limited urban services and encroachment on urban green contributing to urban households' vulnerability to climate change. Herslund et al. argue that, in Dar es Salaam, lack of clarity in the division of responsibilities between national ministries, regional agencies, municipalities and sub-wards has resulted in little collaboration in dealing with disaster management, environment and infrastructure planning. In focus group discussions, government stakeholders rejected the idea of a generic climate change plan, stating that a broad master plan would only further stall action unless it included concrete guidelines and resources for implementing CCA actions.

The authors argue that CCA should be addressed at the urban scale, with measures that deal with problems cities already face, such as flooding or informal settlements. This can mobilise a broad range of stakeholders and enable coordination of adaptation efforts between the city, various sectors and civil society, or the 'local' level. According to the authors, these types of actions could catalyse cross-scalar and longer-term CCA planning. A similar study by Vedeld et al. (2016) aligns with Herslund et al.'s recommendations, naming this planning process 'coproduction of multi-level governance'. Vedeld et al. address resilience and CCA in Saint Louis, Senegal, shedding light on the conditions in which multi-scalar interactions can successfully enable resilience-building efforts. Through a thorough historical and institutional assessment, the paper traces how CCA has been established and operationalised at different levels in Saint Louis. It finds there were high barriers to multi-level climate governance in the city due to a high centralisation of state power and relatively weak municipal level government. However, Vedeld et al. also find instances of successful climate risk management, pointing to a process of 'coproduction in multi-level governance', where the participation of city planners, state actors and citizens has resulted in actions to improve flood risk management. The authors argue that resilience is an analytically useful concept to identify the components of a resilient city, but that the notion of resilience in urban planning should not be limited to the idea of bouncing back; it should also promote co-productive arrangements within a system of multi-level governance.

'...CCA should be addressed at the urban scale, with measures that deal with problems cities already face, such as flooding or informal settlements. This can mobilise a broad range of stakeholders and enable coordination of adaptation efforts between the city, various sectors and civil society, or the "local" level.'

Measuring resilience across scales is particularly relevant for transboundary river basins, where a number of countries, populations, species, political and economic systems all converge. Peterson-Perlman (2016) assesses projected resilience of water management at the global and river basin scale, applying two different assessment methods to the Zambezi River Basin. The global analysis examines hydropolitical resilience using social, political and physical indicators that measure the potential for change and institutional capacity. A global-level analysis using these indicators shows that the Zambezi Basin has relatively high hydropolitical resilience. To better understand this score, Peterson-Perlman conducted an additional analysis at the basin level of institutional capacity, relying primarily on semi-structured interviews of key stakeholders. The basin-scale analysis shows that, although the legal structure is in place, the Zambezi Basin has fairly weak enforcement of basin management arrangements. The author argues

that global-level resilience indicators can be useful but delving into the history of institutional arrangements and socioeconomic systems can provide important nuance to understand the resilience of river basin management. These lessons are relevant for Sun et al. (2016)'s study of resilience to floods in the Chaohu Lake Basin in China, where the authors construct quantifiable resilience capacities using indicators of natural, social, economic, technological and management dimensions of resilience. The evaluation tool is a method of diagnosing flood disaster resilience, and in its pilot application in the Chaohu Lake Basin the majority of the basin scored a 'moderate' or above level of resilience. The paper's focus of measuring regional resilience did not delve into the effectiveness of management efforts, but did show significant variation in indicators of the natural dimension of resilience across the region (including soil erosion, water storage capacity, levels of precipitation and low-lying terrain). Assessing resilience at the basin scale is a complex endeavour, but combining methodologies to understand local institutional capacity can help explain the results of regional or global indices.

Shifting focus away from governments, Averchenkova et al. (2016) review the role of multinationals and large corporations in CCA activities. Large corporations have the capacity to increase the resilience of the workforce and to increase the supply of technologies and services to support climate resilience, although they can also exacerbate the vulnerability of local communities and actors. The authors find that only a minority of companies have started to develop or implement specific CCA measures, although corporations commonly use the language of risk management and resilience in their operational strategies. The authors point to lack of knowledge on drivers of CCA (by the private sector) and the inability to evaluate outcomes of corporate adaptation actions as critical gaps in the field. The authors argue that PPPs have the potential to enable corporations to develop robust adaptation strategies by drawing on government and community knowledge of local contexts, but cautions that profit motives of the private sector may sometimes conflict with CCA goals. Finally, lack of conceptual clarity on what constitutes adaptation and a deficit of any specific benchmark objectives have limited the involvement of multinational corporations in driving CCA and resilience actions.

Runhaar et al. (2016) develop a method of *ex-ante* assessment of responsibilities for CCA, spanning both public and private sectors. The authors argue that slow progress in CCA results from a lack of clarity on the division of responsibilities for adaptation, and present their method as a useful diagnostic tool to identify areas where responsibilities need to be clarified. Using four criteria for CCA responsibilities based on a literature review (comprehensive, transparent, legitimacy, effectiveness), the authors apply the tool to the legal framework governing the information and communications technology sector in the Netherlands. Using this tool, Runhaar et al. find responsibilities are formulated at an abstract level and adaptation actions are not explicitly framed as such. In conclusion, the method is best applied to a particular sector with a relatively limited number of actors. At higher scales with more complex legislation, such as cities, the tool would be more difficult to apply.

Finally, Pescaroli and Alexander (2016) theorise on the role of critical infrastructure in adaptive capacity and vulnerability. The paper's sector-specific focus draws out 'cascades of impacts' on infrastructure and feedback loops with the adaptive capacity of socioeconomic systems. The authors argue that when 'thresholds are crossed, cascading effects are generated with consequent regime shifts across scales and domains' (p.183). Their review of the literature on the vulnerability and resilience of infrastructure shows that neither vulnerability assessments nor contingency planning in isolation suffice for climate adaptation planning, and suggest modelling vulnerability scenarios based on possible escalation points.

4.2 Power, perceptions, and subjective resilience

Academic literature on power, perceptions, and subjective resilience suggests:

- Efforts to enhance resilience must consider issues of power and conflict to understand whose resilience is privileged and potential trade-offs in resilience building
- Perceiving climate impacts is important for adopting climate adaptation actions, and interventions that enhance the understanding of climate impacts, which can facilitate resilience and decision-making at the household level.
- Subjective resilience can complement objective measures of resilience measurement, capturing intangible factors that shape resilience and reveal underlying patterns of vulnerability.
- Perceptions of the role of interventions in enhancing livelihood resilience may differ from the impacts detected by models, with households overestimating the impacts of interventions.

Attempts to theorise or measure the components of resilience often gloss over questions of power. Inequality can constrain people's ability to deal with shocks and stresses, and applying a political ecology lens brings distributional impacts of resilience-building efforts to the forefront. Soliciting people's perspectives directly and including measures of subjective resilience is one method of grounding resilience theories and better understanding how different groups of people cope with shocks and stresses. Similarly, it can elucidate the resilience benefits people perceive from interventions (Merritt et al, 2016). Recent literature shines light on the importance of asking whose resilience is privileged (Cutter et al, 2016; Harrison & Chiroro, 2016), and new studies present assessment tools that capture perceptions and bottom-up perspectives in a more participatory manner (Jones & Tanner, 2016; Choptiany et al., 2016; Opiyo et al, 2016).

Cutter (2016)'s paper questions how the resilience agenda upholds the status quo and perpetuates the vulnerability of certain groups of people. She argues that asking the obvious, yet important, questions of "Resilience to what? Resilience for whom?", is critical to understand whose resilience is privileged. According to the paper, the literature on resilience has largely failed to acknowledge the complexity of communities, the root causes of vulnerability, or the trade-offs that building resilience may entail. The paper argues that asking whose resilience is privileged moves resilience thinking beyond assets or characteristics of systems, bringing a nuanced understanding of power and complexity in socio-ecological systems. Harrison & Chiroro (2016)'s study reinforces this sentiment, arguing that a focus on resilience should not ignore the manners in which communities are differentiated. Though resilience thinking often defers to a language of systems and stability, the authors aim to highlight differentiation, power, and conflict in their work. The authors argue for an approach that unpacks local political histories and attempts to understand relationships between communities and higher level institutions. Using a evidence from a development project in Malawi, the authors demonstrate that one group's resilience can come at the expense of others, and that questions of control of resources and whose voices are heard are particularly relevant in resilience

Three more studies emphasize the role of perceptions and self-assessment in understanding resilience (Opiyo, 2016; Jones & Tanner, 2016; Choptiany et al., 2016). Capturing the views of vulnerable people is important for directing resilience and better understanding what works in resilience building. In an empirical study of pastoralists in Turkana, Kenya, Opiyo et al (2016) directly elicit the perceptions of pastoralists to better understand the factors that impact their adaptation decisions. Their study identifies factors that influence households' perception of and adaptation to climate change. Over 96% of respondents perceived changes in climatic factors, though female headed-households were slightly more likely to perceive a change in climate than male-headed households. Female headed households were also more likely to take up climate change adaptation actions, which the authors argue is because women were taking part in more farm-based production practices in the study area. Livestock ownership and herd size were also important factors in the adoption of adaptation actions, as households' with larger herd sizes were more likely to have resources to diversify their income. Lastly, the study finds that households with access to extension services are more likely to perceive climate changes. The study suggests investments in women's empowerment, pro-poor policies on access to extension services and social protection schemes for the vulnerable are important actions to enhance pastoralists' resilience to climate change.

In the past year, efforts to directly measure people's perceptions of their own resilience have spawned a new concept: subjective resilience. Jones and Tanner (2016) unpack the concept, highlighting advantages and disadvantages in using measures of subjective resilience alongside objective measures. The authors define subjective resilience as people's perceived level of household resilience to specific external shocks and stresses, which is shaped by people's valuation of their ability to manage their livelihood in the face of disturbance. It is related to culture, perceptions of risk, cultural norms and issues of power and marginalisation. The authors argue that measuring subjective resilience can foster better accountability of NGOs and governments to beneficiaries, reveal underlying or intangible causes of vulnerability and resilience that do not show up in traditional surveys and serve as a mouthpiece for the voices of beneficiaries and local communities.

Choptiany et al. (2016) present SHARP, a tool that aims to integrate a traditional survey with a participatory self-evaluation component to better assess resilience. The tool was piloted using a tablet-based survey with components that allow communities to assess their climate resilience priorities, allowing them to self-evaluate the importance of different farm and pastoral components of their livelihoods. The tool is intended to be pragmatic, helping farmers and pastoralists develop specific strategies that are more resilient to climate change. Although the tool calls for a self-assessment, it is not an attempt to measure subjective resilience, as in Jones and Tanner (2016). Instead, it measures agro-ecosystem resilience and

explores community-based strategies for climate adaptation.

Lastly, Merrit et al. (2016)'s study on livelihood resilience to droughts in Indian watershed development (WSD) programmes found that households perceived a larger benefit to their resilience from WSD than the impacts that were detected using a Bayenesian model. Under this model, the authors used the sustainable livelihoods framework to understand the impacts of WSD interventions. The results show that, in areas where one livelihood capital is strong, the others are more likely to be strong. This was particularly relevant for natural capital, which was associated with strong financial and human capital. The study found that resilient households perceived higher impacts from WSD than less resilient households did, though the authors do not attempt to explain the discrepancy between perceived and actual benefits to resilience detected by the model.

Farmer weeding maize field in Bihar, India. Photo: International Maize and Wheat Improvement Center, 2012.

4.3 Adaptive capacity in agro-ecological systems

Academic literature on adaptive capacity in agro-ecological systems suggests:

- A vast array of factors affect the resilience of socio-ecological and agro-ecological systems, and tracking the resilience of these systems requires monitoring components of resilience that span social, ecological, cultural and economic indicators.
- There are low rates of adoption of climate adaptation actions by smallholder farmers, and many of the barriers to adoption are at scales higher than the household, such as issues of market access, land tenure systems and infrastructure.
- Supporting adaptive capacity must consider the short-term costs and benefits of adoption of climate-smart agriculture techniques, promoting techniques that yield positive impacts in the one- to two-year timescales that smallholder farmers prioritise.
- Mapping social and ecological factors geospatially is key to informing local decision-making and planning for resilience.

Eight papers in this quarter's sample investigate resilience and adaptive capacity in the context of agro-ecological systems. These draw links between wider ecosystem functions and household resilience, highlighting the important but nuanced role of crop diversification, water management knowledge and cultural norms in the sustainability of these agro-ecological systems (Castonguay et al., 2016; Maleksaeidi et al., 2016; Bahadur et al., 2016). The sample largely focuses on smallholder farmers, with an emphasis on opportunities and constraints in adaptation to climate stresses (Descheemaeker et al., 2016; Pauline et al., 2016; Mutambara et al., 2016).

Castonguay et al. (2016) examine the adaptive capacity of social-ecological systems, using the rice terraces in Banaue, Philippines, as a case study. They note the increasing pressures on the system, which is a UN Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site, including environmental degradation, pressures from increasing trade, uncoordinated tourism development, the introduction of invasive species and erosion of traditional cultural norms. The authors surveyed farmers for their perception of these changes, and

found some indicators of resilience had remained constant over time, including nutrition diversity, food self-sufficiency and the primogeniture inheritance system, demonstrating that some ecosystem services and related benefits have been conserved in spite of the sweeping changes. The authors argue that assessing the viability of the long-term development of agro-ecosystems requires monitoring diverse components of resilience (social, ecological, cultural, economic) regularly. Maleksaeidi et al. (2016) also measure and categorise farm household resilience, focusing specifically on water-scarce regions of Iran. The authors use more household-focused metrics to define resilience capabilities than Castonguay et al. do, tracking indicators related to education, water security, land ownership, insurance coverage and psychological traits. Their empirical study finds that dependence on climate-sensitive resources such as water decreases household resilience, and houses closer to wetlands are more vulnerable. It also finds that involvement in extension activities and knowledge on water scarcity makes a significant difference to the household's resilience. Highly resilient households are characterised by certain psychological traits, such as higher extraversion, openness to new experiences, conscientiousness and a lower neuroticism score than households that are categorised as having 'low' or 'medium' resilience. The authors recommend building household farm resilience by increasing household capacity to use knowledge related to water scarcity and strategies to withstand it.

Lastly, one paper focuses on the role of crop diversity in particular in enhancing resilience. Bahadur et al. (2016) test the relationship between agro-biodiversity and sustainable and resilient food systems, examining farming families in three agro-ecological regions of Nepal. The wider literature suggests that agro-diversity is an important component of sustainable food systems because it offers greater stability and resilience for people who depend on it. The authors find that households that cultivated diverse crop species are indeed more food self-sufficient, but that education and market access also play an important role. The study finds stronger interactions between food self-sufficiency and crop diversity in poorer areas with low access to markets. The authors suggest that low-income households can increase their resilience through crop diversification, but that richer households can afford to choose between crop diversification and intensive monoculture without compromising their resilience.

In their study of resilience in agro-ecological systems, Descheemaeker et al. (2016) investigate climate impacts on African smallholder crop–livestock systems to adapt to and mitigate climate change, highlighting the options and barriers in relation to adaptation in mixed crop–livelihood systems. The paper highlights that adaptation solutions, such as improved technologies or techniques, are characterised by low adoption rates by smallholder farmers. The authors find some consistent constraints to the adaptive capacity of these crop–livestock farming systems, including malfunctioning extension services, poor community organisation, limited labour resources and insecure access to natural capital. At higher scales, the authors point to communal land tenure systems as a disincentive for investments in improved rangeland management. Although there is a wide range of heterogeneity in the agro-ecological systems across the continent, the authors argue that transformational change is required to support the resilience of smallholder farmers. Such change should enable farmers to better manage climate risks in their small farms, which the authors posit is the primary barrier to improving livelihoods and resilience. Pauline et al. (2016), on smallholder farmers in Tanzania, also suggest smallholder farms lack adaptive capacity to climate stresses, with climate factors interacting with non-climatic stressors to erode household resilience. The authors find that, in the face of rainfall variability, smallholder farmers resort more frequently to short-term coping strategies rather than long-term adaptation actions. To move away from shorter coping strategies and support better planning for CCA, the authors recommend better access to affordable agricultural inputs, irrigation infrastructure and boreholes and market development options.

Mutambara et al. (2016)'s study of water management sustainability challenges in smallholder farms chronicles a history of failed irrigation schemes.

'The study finds stronger interactions between food self-sufficiency and crop diversity in poorer areas with low access to markets. The authors suggest that low-income households can increase their resilience through crop diversification, but that richer households can afford to choose between crop diversification and intensive monoculture without compromising their resilience.'

Iraqis displaced by conflict. Photo: IOM/UN Migration Agency, 2014.

The authors compare the African experience with agricultural water management schemes in Asia to derive lessons on how to make African smallholder irrigation schemes more resilient. As in Descheemaeker et al.'s study, insecure land tenure systems are identified as a key barrier to resilient water management practices. The authors contend that addressing land rights to ensure water management systems meet the needs of smallholder farmers will improve farmers' willingness to pay utility bills. The authors also cite other methods of improving resilience, including leveraging indigenous knowledge in community irrigation schemes, establishing pro-poor water markets and investing in the exploitation of underground water with private sector participation to support NGO-based water development projects. In particular, they emphasise the importance of farmer involvement in the rehabilitation and active management of irrigation schemes.

The challenges, barriers and opportunities involved in CCA in agro-ecological systems are associated with certain costs. Sain et al. (2016)'s study applies a CBA of adaptation actions in agro-ecological systems, focusing on eight climate-smart agriculture techniques in the Dry Corridor in Guatemala. The authors find that all practices but one were profitable over their lifecycle, though the time lag between the positive impacts of climate smart agriculture and the initial action was about two years, which could be too long for small producers. Actions with faster returns for farmers included introducing disease tolerant varieties, introducing heat and water stress-tolerant maize varieties and using crop rotation. Sain et al.'s analysis is an important method to inform investment decisions in agro-ecological systems, particularly for small-scale farmers that cannot afford to wait for years to observe the benefits of adaptation choices.

Lastly, one study presents a tool that can support governments to conduct down-scaled planning for resilience by spatially mapping the social and ecological factors that are key for climate resilience. Bourne et al. (2016)'s paper explains how this tool was designed to support decision-making and planning for ecosystem-based adaptation at the local level, testing it in South Africa in arid and mesic systems. Using a GIS-based multi-criteria analysis and vegetation distribution models, the tool combines local ecological and social information, relying on publicly available datasets and elucidating this information at a scale that local authorities can apply to the political units they manage. Combining socioeconomic features and ecological features is key to holistic resilience planning, and this approach aims to provide governments with the information they require for local-level decision-making for resilience and adaptation.

4.4 Migration and displacement

Academic literature on migration and displacement suggests:

- Debates on migration as an adaptive response to climate change have neglected issues of the interconnectedness between places of destination and home, and the role this plays in the resilience of individuals and communities.
- Current research on social-ecological resilience can shed light on the interactions between migrants and ecosystems.
- Ensuring resilient livelihoods in cases of forcible relocation should build on the organic livelihood processes that emerge after relocation.

Two studies in the sample address issues of migration and displacement, bringing new perspectives to characterisations of resilient migrants or relocated populations. Ramanath (2016)'s empirical study recommends a role for NGOs to support the organic livelihood processes that emerge after forcible relocation. In their study of the 'environment–migration' nexus, Sakdapolrak et al. (2016) introduce the concept of translocal social resilience, in which migrants' trajectories are understood as multidimensional, connected and part of a broader socio-ecological system in which climate may be a small factor. Both studies call into question traditional paradigms of migration, displacement and resilience, and call for an approach that better matches the realities of people's lives as they move from one location to another.

The literature increasingly frames migration as a form of climate adaptation. Sakdapolrak et al. (2016) aim to push the analysis of migration in the context of climate change further by moving beyond a rationalist interpretation of the 'environment–migration' nexus. They call attention to issues of root causes of vulnerability and the role of migration in wider socio-ecological systems. The approach disavows what it deems a neoliberal climate adaptation discourse, which describes migration as an individual response to climate risks and places the burden of adaptation on (often disempowered) individuals rather than states. The authors review the theoretical evolution of the concept of migration as climate adaptation, emphasising that this narrative has often overplayed the role of environmental push factors and largely ignored the patterns of connectedness between destination areas and home. The authors present a 'translocal social resilience' approach to understanding the environment–migration nexus, arguing that a dynamic and multidimensional notion of place is needed. They advocate for including stronger linkages to current research on social-ecological resilience and ecosystem services. To understand the relationship between migration and the environment, researchers and policy-makers should take into account complex social and ecological interactions that stop characterising ecosystems as simply 'threats' or 'resources' and pay greater attention to patterns of connectedness.

'The authors review the theoretical evolution of the concept of migration as climate adaptation, emphasising that this narrative has often overplayed the role of environmental push factors and largely ignored the patterns of connectedness between destination areas and home.'

Drawing on 120 interviews with recently resettled women in Mumbai, Ramanath (2016) explores the responses and resilience of women who were moved involuntarily from urban slums into social housing, where they were forced to rebuild their livelihoods in an unfamiliar location. The study argues that NGOs involved in the resettlement process tended to function more as state contractors than as representatives of the poor. Rather than assuming NGOs can provide what the resettled need, Ramanath argues that resettlement efforts should build on ways of life that emerged organically in the aftermath of an involuntary move to better support livelihood resilience. The article uses the concept of sense-making as a framework for determining the strategies women employ to understand changes in their livelihoods. Based on their responses, the article recommends ways of improving livelihood resilience in an empowering way, including ensuring safety in the new environment; coordinating and protecting informal savings and credit associations that existed in the resettlement site; and helping residents have access to and better control over informal subcontracted work that could otherwise be highly exploitative. The type of support women themselves desired was beyond the normal paradigm of 'gender-neutral, casteless and integrative' approaches to resettlement and resilience most NGOs follow.

5. Understanding the characteristics of resilience in 2016 Q1 literature

As the preceding sections show, multiple disciplines and domains of practice employ resilience thinking. This section draws out connections between them to understand the directions in which this growing field is moving. It interprets the literature discussed in the scans of blogs, academic and grey literature based on five broad characteristics of resilient systems identified by the Rockefeller Foundation. These are distilled through a consideration of a wide body of research on the topic.

5.1 Awareness

Awareness is the ability to constantly assess, learn and take in new information on strengths, weaknesses and other factors through sensing, information-gathering and robust feedback loops.

Key messages:

- There is a need to shift from static to dynamic risk assessments that reveal the drivers of risk.
- Subjective and psychosocial measures and aspects of resilience can enhance our overall understanding of people's resilience and the impact of shocks and stresses.
- Despite recent efforts, there is still a long way to go in fully developing and establishing accurate and adequate M&E methods for assessing resilience.
- Tracking perceptions of resilience can be used as a tool to foster accountability to NGOs and governments, plan resilience interventions and highlight discrepancies between scientific models and self-assessments.

The majority of the papers in the grey literature scan align with the characteristic of awareness, as they refer to methods of assessing and measuring risk and resilience. By highlighting different methodologies for measuring outcomes, for instance effects on well-being, objective resilience and psychosocial and subjective resilience, the papers highlight the complexities many practitioners and policy-makers are facing or will face in attempting to measure resilience.

Many of the authors cite information-gathering, accurate data and risk-modelling as major components of their operational and organisational frameworks for building resilience. These organisational frameworks often feature approaches to assess, learn and gather information on the changing dynamics of vulnerability, capacity and risk interventions informed by an understanding of the causes of these risks, fragilities and vulnerabilities (Oxfam, 2016; GFDRR, 2016; World Bank, 2016b). The authors note this need for understanding existing trends but also the need for continual learning, innovation and experimentation so as to maintain pace with changing contexts, shocks and stresses (Oxfam, 2016).

The need for accurate measurements of resilience appears as a key theme in the grey literature demonstrating assessment, learning and feedback loops. Measurement of resilience in these papers is seen as a means of understanding impacts and informing and tracking performance of resilience-building initiatives (Pasteur and McQuistan, 2016). Authors focusing

'The need for accurate measurements of resilience appears as a key theme in the grey literature demonstrating assessment, learning and feedback loops.'

on resilience measurement identify the need to assess capacities for resilience (including absorptive, adaptive and transformative capacities) in order to gain a more comprehensive understanding of the relationship between shocks and resilience (Daze and Dekens, 2016; Bower et al., 2016; Constas et al., 2016; Béné et al., 2016; Jones and Samman, 2016; Ulrichs, 2016; Oxfam, 2016a). In terms of methodologies for measuring resilience, authors highlight the importance of on-going monitoring and the use of subjective as well as objective data (Bower et al., 2016). M&E processes for resilience projects are also identified as underdeveloped and requiring greater time and learning (Pasteur and McQuistan, 2016; Williams, 2016).

The focus on subjective resilience in the grey literature supports greater reflexivity, learning and feedback loops in resilience-building efforts. Some authors set out guidance to help NGOs, development agencies and others focus on the less tangible psychosocial and subjective factors that influence resilience (Béné et al., 2016; Jones and Samman, 2016). There is also acknowledgement that the complexity of comprehensive approaches that capture both subjective and objective factors must be balanced with the availability and feasibility of the data required (Hallegatte et al., 2016). Another group of papers highlights the need to raise risk awareness at different levels, particularly in the case of early warning systems, while also noting that the information required to achieve this is often contained in siloes and is therefore difficult to access (Sugden, 2016; World Bank 2016b).

‘Using measures of subjective resilience can shed light on these discrepancies, and point to cultural factors, differing perceptions of risk and issues of marginalisation that may help explain how resilience manifests differently within communities and across continents (Jones and Tanner, 2016).’

The academic literature delves into concepts of awareness, primarily by examining the role of people’s perspectives and subjective assessments of their own resilience in resilience measurement efforts. Empirical studies show how subjective resilience metrics can feed into participatory resilience planning efforts, and how subjective assessments and perceptions are not always in line with assessment models built by experts. People’s direct perspectives and participation inform efforts to track resilience and better target resilience investments.

Similarly, the academic literature focuses on subjective resilience, arguing that eliciting people’s perspectives is a method of fostering accountability, better directing resilience investments and documenting

School girls in Senegal. Photo: Angela Sevin, 2007.

intangible factors that affect resilience (Jones and Tanner, 2016). Tracking subjective resilience is one lens to help practitioners monitor and assess trends reliably at different geographical and temporal scales (Jones and Tanner, 2016; Choptiany et al., 2016). The academic literature also shows that, in some cases, people's perceived benefits from resilience-building activities are not aligned with actual benefits derived from modelling impacts, with people perceiving more positive impacts than those detected by the model (Merritt et al., 2016). Using measures of subjective resilience can shed light on these discrepancies, and point to cultural factors, differing perceptions of risk and issues of marginalisation that may help explain how resilience manifests differently within communities and across continents (Jones and Tanner, 2016). As in the grey literature, the authors who apply subjective resilience measures do so alongside more objective measures of resilience, using both to inform efforts to track resilience (Jones and Tanner, 2016; Choptiany et al., 2016).

5.2 Diversity

Diversity implies that a person or system has a surplus of capacity such that it can operate successfully under a diverse set of circumstances, beyond what is needed for everyday functioning or relying on only one element for a given purpose.

Key messages:

- Diverse skills, capacities and approaches are required to respond to diverse shocks and stresses within complex and varied contexts.
- In order to accurately measure resilience, a diverse set of context-specific indicators is required.
- The resilience of diverse components of social-ecological systems is interconnected, and there is scope to better understand the feedback loops between different scales and dimensions of these systems.

Papers that reflect the characteristics of diversity in the grey literature focus on livelihoods, biodiversity and gender equality. In terms of agriculture, authors note the need for diversity in agro-ecosystem crops in order to help provide farmers with the capacity to adapt to the changing climate, and to help build their resilience to shocks and stresses. Moreover, authors highlight the range of different social, environmental, economic and political contexts that may affect how successful an initiative is, highlighting that crop diversification must be context-specific (Nelson et al., 2016; Venturini et al., 2016).

'Understanding which factors are important to which groups is key to better targeting resilience investments and understanding the diversity within agro-ecological systems.'

The grey literature also highlights the different skills and capacities people can use to prepare for, cope with and respond to shocks and stresses. This is demonstrated through recommendations for analysis of subjective and objective resilience and the role of social capital in increasing resilience as well as a presentation of the different skills, roles and responsibilities women and men have in responding to risk (Bower et al., 2016; Jones and Samman, 2016; Béné et al., 2016; Woodson et al., 2016; Hallegatte et al., 2016; Sridarran, 2016; Kratzer and le Masson, 2016; AIDMI, 2016). Diversity is also highlighted in relation to the operation of food supply chains in that a number of authors recommend diversification of sources as a means of building resilience to shocks (Reddy et al., 2016; FAO, 2016a; Dorosh et al., 2016).

In the academic literature, diversity features primarily in papers examining resilience in the context of socio-agro-ecological systems. The literature shows both the diversity and breadth of the factors that have an impact on resilience, and also the varying importance of these factors for different groups of people. The strong focus on socio-ecological and agro-ecological systems indicates greater efforts to understand resilience at the system level, where there are a diversity of actors and factors shaping resilience outcomes.

Two academic papers attempt to track adaptive capacity within the context of these systems, showing that diverse elements of the system are interconnected. In Banaue, Philippines, uncontrolled tourism and environmental degradation have had impacts in terms of the erosion of traditional norms, the viability of farming practices and the introduction of invasive species (Castonguay et al., 2016). In a study of farming systems in Iran, dependence on climate-sensitive resources was associated with a lower resilience score. At the micro level, psychological traits such as 'openness to new experiences' and 'conscientiousness' were associated with higher resilience scores (Maleksaeidi et al., 2016). Tracking resilience requires measuring diverse elements of the system, from the micro-level individual factors to the macro factors found in the wider ecosystem.

In these diverse socio-agro-ecological systems, some factors may be important for the resilience of

some households but not others. Bahadur et al. (2016) examine the role of crop diversity in fostering resilience in three agro-ecological regions of Nepal. In testing the relationship between resilient food systems and crop diversity, the study finds increasing crop diversity is an important resilience strategy for low-income households. Wealthier households and households closer to markets can choose between crop diversification and mono-culture without affecting their resilience. Understanding which factors are important to which groups is key to better targeting resilience investments and understanding the diversity within agro-ecological systems.

5.3 Self-regulation

This implies a system can deal with anomalous situations and interferences without significant malfunction, collapse or cascading disruption. This is sometimes called 'islanding' or 'de-networking' – a kind of 'safe failure' that ensures any failure is discrete and contained.

Key messages:

- A resilient food supply chain relies on the self-regulating nature of its actors, support services and external infrastructure.
- In order to avoid cascading disruptions, responses to multi-hazards require adequate disaster risk and crisis governance present at all levels and across all sectors.
- The vulnerability of critical infrastructure can cause 'cascading disasters', which are a product of and feed into social and economic systems.

A number of grey literature papers highlight the networks that exist within systems, and the reliance on different parts of a system that will help build resilience or lead to cascading disruptions. For instance, three papers touch on the concept of self-regulation in relation to FSCs and value supply chains (Reddy et al., 2016; FAO, 2016a; Daze and Dekens, 2016). The papers suggest overcoming dependencies and therefore the risk of cascading disasters through dual or multiple sourcing (Reddy et al., 2016), adequate disaster risk and crisis governance at all levels (FAO, 2016a) and increased awareness of climate risks as well as the means of continually managing these risks (Daze and Dekens, 2016). A number of reports also stress that actions to build resilience within these chains are mutually reinforcing and therefore require a multi-hazard, cross-sectoral approach.

Although the majority of academic papers in this quarter's sample do not engage with this characteristic, the concept of 'safe failure' features in a conceptual analysis of the vulnerability of critical infrastructure. Pescaroli and Alexander (2016) explore the role of critical infrastructure in adaptive capacity, vulnerability and resilience. The authors argue that the vulnerability of critical infrastructure in interdependent systems can spread 'cascading disasters', and that these are not low-probability, high-impact events but are well rooted in current social structures. Corruption, maximisation of profit and negligence all play a role in undermining the resilience of infrastructure and in causing cascading disruptions. To enhance self-regulation, the authors point to a need for wider integration of social behaviour and systems thinking into our design and maintenance of critical infrastructure.

5.4 Integration

Being integrated means individuals, groups, organisations and other entities have the ability to bring together disparate thoughts and elements into cohesive solutions and actions. Again, this requires the presence of feedback loops.

Key messages:

- Resilience can be enhanced through the integration of social protection initiatives into DRM and climate resilience-building strategies.
- There is the need for further integration of gender into CCD initiatives, particularly in urban areas.
- Greater integration between international policy frameworks will help address underlying vulnerabilities and promote coordination between the CCA and the DRR sectors.
- To integrate a wide variety of actors in climate adaptation and resilience, there need to be clearly delineated responsibilities between scales and sectors.
- The process of working together is often as important as the policy outcomes, and co-production between multiple levels of governance helps ensure successful resilience outcomes.

Integration is a key theme across the grey literature on gender, international policy and social protection. Two papers highlight the importance of integrated, participatory and coordinated approaches to gender-sensitive CCD as well as the integration of gender into all climate-relevant policies (Kratzer and le Masson, 2016; Dieu, 2016). These note the need to strengthen mechanisms for the integration and provision of adequate resources to ensure women have an equal role in developing climate resilience.

The integration of social protection into DRR and climate resilience-building initiatives was also

highlighted; both the integration of climate resilience into the design of social protection initiatives and the addition of social protection components to climate resilience initiatives are proposed (Wallis and Buckle, 2016; Woodson et al., 2016). This linking of programmes and therefore networks of institutions involved in disaster response will only further enhance the coordination of efforts after a shock (Woodson et al., 2016).

Papers that focus on urban resilience also highlight the need for integrated approaches to building resilience. For instance, a number of papers stress the importance of an integrated approach to tackling disaster risk in urban areas. This would include multi-stakeholder and multi-level collaboration, such as the aligning of national and city government goals in order to establish and foster an enabling environment for incentivising investment in DRR (ADB, 2016; Alam et al., 2016).

Finally, integration is highlighted in the grey literature with regard to the coordination and coherence of different frameworks and approaches for DRR and resilience-building initiatives. A number of papers argue the need for collaboration, coherence, integration and mutual reinforcement between different international policy frameworks (the Sendai Framework for DRR, the SDGs and the Paris climate agreements) as well as among UN agencies working on DRR and CCA, in order to address underlying vulnerabilities and cross-cutting issues (ADRRN, 2016; UN, 2016). Sridarran et al. (2016) further highlight the need for integration and cohesion in more general terms between DRR and CCA initiatives and the agencies working on these issues.

Integration features prominently in the academic literature, with five papers explicitly addressing how to work across scales with a multitude of actors to deliver climate adaptation actions (Runhaar et al., 2016; Averchenkova et al., 2016; Vedeld et al., 2016; Herslund et al., 2016; Termeer et al., 2016). Though the enabling conditions for better integration of these actions depends on the context, the papers emphasise the importance of a clear division of responsibilities between actors. Vague or generic climate change plans are not useful unless they include specific guidelines and resources for implementing climate adaptation actions (Herslund et al, 2016). Adaptation actions are not often framed as such, resulting in slow progress in climate adaptation between the private sector and governments (Runhaar et al., 2016). For the private sector, having specific benchmarks or objectives could facilitate the involvement of more multinational corporations in driving actions (Averchenkova et al., 2016).

The academic literature highlights that successful integration is not only about the outcomes produced (i.e. a climate change plan with clearly articulated responsibilities) but also about the process of working together. In a study of climate adaptation at the city level, engaging in a process of 'coproduction of multi-level governance' was key for successful collaboration between national, regional and municipal organisations (Vedeld et al., 2016). When applied at higher scales, this process of co-production is essential to ensure climate adaptation actions are suited to local contexts and regional and global ambitions. Local and global interests for climate adaptation can clash, and creating the right institutional conditions for collaboration is key to facilitating CCA (Termeer et al., 2016).

5.5 Adaptiveness

Adaptiveness is the capacity to adjust to changing circumstances during a disruption by developing new plans, taking new actions or modifying behaviours so you are better able to withstand and recover from it, particularly when it is not possible or wise to go back to the way things were before. It also suggests flexibility and the ability to apply existing resources to new purposes or for one thing to take on multiple roles.

Key messages:

- Adaptive capacity is a fundamental aspect of resilience and is therefore commonly used as an indicator in methods for measuring resilience.
- People's adaptation-related decisions are just as frequently determined by subjective factors as they are by objective ones.
- Perceiving changes in climate is important for facilitating adoption of adaptation actions, and extension services can play a role in facilitating an awareness of climate change.
- Migration can be conceptualised as a form of adaptation, but understanding the connections and feedback dynamics between places of origin and places of destination should not be neglected.

A number of papers in the grey literature highlight adaptive capacity and management as an important aspect to help people and systems prepare for, cope with and respond to shocks and stresses. A number of authors describe adaptive capacity and adaptive management as key to building resilience in different systems, such as agricultural value chains (Daze and Dekens, 2016), programmes for smallholders and women (Oxfam, 2016b) and analytical frameworks for identifying vulnerability (Pasteur and McQuistan, 2016). Other papers describe vulnerability or resilience as being dependent on adaptive capacity, which in

‘Evidence from the literature suggests that people’s decisions on whether to adapt or not are often based on the subjective perception of a person’s adaptive capacity rather than their objective ability to adapt (Béné et al., 2016; Jones and Samman, 2016).’

turn depends on a myriad of factors, such as access to assets and services, which can help support changes in resilience (Wallis and Buckle, 2016).

Many authors also use adaptive capacity as a measurement or outcome of resilience (Daze and Dekens, 2016; Bower et al., 2016; Constas et al., 2016; Béné et al., 2016; Jones and Samman, 2016; Ulrichs, 2016; Oxfam, 2016a). In particular, RIMA-II, FAO’s framework for measuring resilience, includes adaptive capacity as one of the four fundamental pillars that characterise resilience and describes it as a multidimensional concept that is determined by complex relationships between different factors at varying scales (FAO, 2016c).

Section 3.4 on Social aspects of resilience also demonstrates the different ways in which people are able to adapt to shocks and stresses. Evidence from the literature suggests that people’s decisions on whether to adapt or not are often based on the subjective perception of a person’s adaptive capacity rather than their objective ability to adapt (Béné et al., 2016; Jones and Samman, 2016). Other papers highlight the role of social capital and social protection in building adaptive capacity through tight knit networks that support each other in times of crisis or through the facilitation and promotion of sustainable livelihoods (Bower et al., 2016; Ulrichs, 2016).

The salience of perceptions in adaptation choices features prominently in the academic literature. Evidence from pastoralist communities in Turkana, Kenya, shows that perceptions of climate change are higher among households that have access to extension services, and that perceiving changes in climate is important for implementing adaptation actions (Opiyo et al. 2016). Self-assessments of resilience can also play a role in supporting adaptation planning, as they bring to the fore the factors that are most important to a household or community’s livelihood resilience (Choptiany et al., 2016).

Lastly, the literature examines the role of migration in CCA debates. Sakdapolrak et al. (2016) argue that the idea of migration as an adaptive response to climate change puts too much emphasis on environmental risks and neglects the multidimensional ways that communities themselves build resilience. Migration is not a straightforward adaptive response to climate, and the authors propose a ‘translocal social resilience’ concept to better describe the environmental–migration nexus. The translocal social resilience approach advocates for a better understanding of the connectedness of actors through social networks, rather than focusing only on the push to destination areas in ‘adaptive’ migration choices.

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Annex: Blog visibility methodology

1. Measuring visibility

The purpose of this initial step is to offer a bird's-eye view of the resilience blogosphere:

Using blog search engines, Boolean search queries were performed to identify blogs that publish about resilience in different contexts. This initial exploratory search identified the top 50 resilience blogs, with the criterion being how visible the relevant blog content is on the web. This ranking was derived by a score based on Google PageRank, Page Authority, Domain Authority.

The next step involved narrowing down the list to the top 25 resilience blogs. With the initial list ranked by search engine visibility and content relevance, the 50-blog list was manually reviewed to exclude blogs that:

- have low keyword/subject matter relevance.
- are link farms and blog aggregators, which do not publish original content or syndicate posts from other blogs.
- have no active comment sections or measurable social sharing features.
- posted no relevant updates in 2016.

2. Who published the most popular blog posts on resilience in 2016?

Measuring impact

A complete manual review and analysis of resilience-related blog posts published in the first half of 2016 was performed, and the top 25 blog posts were identified based on metrics of social shares and comments/reader engagement. A score was derived by aggregating the following metrics:

- blog comments
- Facebook shares
- Facebook 'likes'
- Facebook comments
- Twitter shares
- LinkedIn shares

The list was then ranked by aggregate impact score to present the top 25 resilience blog posts of Q1-2 2016.

ODI is the UK's leading independent think tank on international development and humanitarian issues.

ISSN: 2052-7209

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